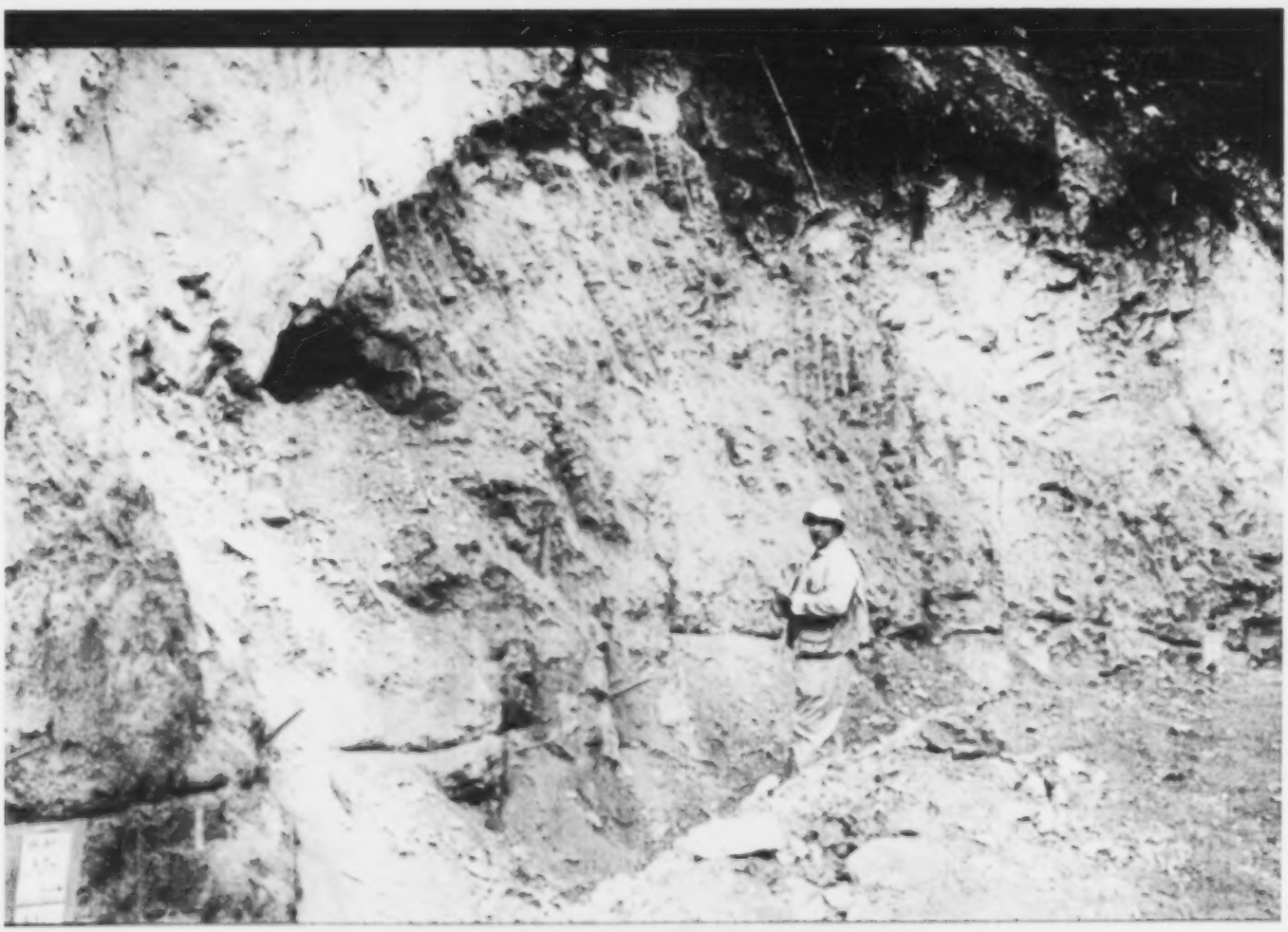
BRITISH COLUMBIA

Ministry of Energy and Mines
Energy and Minerals Division
Mines Branch

Exploration and Mining in British Columbia - 2000



105-06059/

BRITISH COLUMBIA

Ministry of Energy and Mines
Energy and Minerals Division
Mines Branch

Exploration and Mining in British Columbia - 2000

Energy and Minerals Division
Mines Branch

COVER PHOTO...

George Gorzynski, project manager, Redhawk Resources Inc. at Trench B-2000-1, Redbird Zone B, Remac zinc oxide project, 22 kilometres south of Salmo. (12.8m @ 12.65% Zn).

Canadian Cataloguing in Publication Data
Main entry under title:
Exploration and mining in British Columbia. - 1998-

Annual.
Continues: Exploration in British Columbia. ISSN 0823-2059.
ISSN 1491-4646 = Exploration and mining in British Columbia

1. Mines and mineral resources - British Columbia - Periodicals. 2. Prospecting - British Columbia - Periodicals. 3. Geology, Economic - British Columbia - Periodicals. I. British Columbia. Mines Branch.

TN270.B74 622'.1'09711 C99-805843-3

NANAIMO

BRITISH COLUMBIA
CANADA
APRIL 2001

FOREWORD

This volume provides details of exploration, development and mining activity in British Columbia during calendar year 2000. Reviews of activity are provided by regional geologists based in Mines Branch offices in Nanaimo, Kamloops, Cranbrook, Prince George, and Smithers. In addition, there are several short exploration-oriented papers by Mines Branch or Geological Survey Branch staff.

Exploration activity in British Columbia registered a slight improvement in year 2000. Spending is estimated at $27 million, up slightly from the $25 million spent in 1999. Exploration drilling was up marginally to about 180 000 metres. A little over half of the drilling was at operating mine sites, and almost half of that was at the Elk Valley coal mines. The most encouraging sign for year 2000 is that claim staking activity was up sharply as a result of several new grassroots discoveries. Over 28 000 new claim units were recorded during the year, a gain of 68% relative to 1999.

New discoveries highlighted the year's exploration results. Early in the year, the **Bonanza Ledge** auriferous pyrite body was discovered by drilling in the Wells-Barkerville gold belt. This prompted a staking rush with about 7900 claim units recorded. Later in the year, several new polymetallic massive sulphide prospects were discovered elsewhere in southern British Columbia, including: the **Fox** in Nicola volcanic rocks near Merritt; the **Spire** near the Goldstream mine north of Revelstoke; several zinc-lead showings in metamorphic rocks on the **Broken Hill** property near Blue River; the **Silver Lynx** in Rossland volcanics near Nelson and the **Raven** on Nootka Island. Some of these will be drilled in early 2001.

Base metal targets were the focus of many of the advanced exploration projects in the province. The **Remac** property near Trail was explored for carbonate-hosted zinc oxide mineralization. At the past-producing **Afton** mine near Kamloops, deep holes evaluated a high-grade, breccia-hosted, alkalic porphyry copper-gold deposit. Porphyry copper-gold mineralization was also tested at **Morrison** and **Ann North** while polymetallic skarn-manto targets were drilled at **Lustdust** and redbed copper deposits were drilled at **Sustut.** At **Silvertip**, underground holes were drilled to define a silver-zinc-lead manto deposit.

The sharp rise in prices of platinum group metals (PGMs) rejuvenated worldwide interest in these metals. In British Columbia, it spurred grassroots prospecting in numerous locations, and re-evaluation of known nickel, copper and chromite prospects. Interest in PGMs is expected to increase in 2001.

British Columbia's mines and quarries produced a wide variety of solid mineral commodities in 2000. Based on the value of production, the most important of these are metallurgical coal (28%), copper (25%), structural materials (15%), gold (12%), zinc (9%), silver (5%), molybdenum, lead, industrial minerals and thermal coal. Despite continued low prices for coal and most of the metals through 2000, the total value of solid mineral production is forecast at $2.84 billion, up from $2.6 billion in 1999. The increase in value is mainly due to higher production at **Highland Valley, Myra Falls** and **Kemess** mines.

Among the operating mines, the most significant event during the year was the permanent closure of the **Quintette** mine in the Northeast coalfields in August. The low price of coal was cited as the reason for closure. The **Endako** mine continues to work with the Job Protection Commission on an economic plan that would keep the mine operating beyond a May 2001 closure, which is planned due to the low price of molybdenum. The **Sullivan** zinc-lead-silver mine will close in December, 2001 due to exhaustion of reserves. The **Kemess** copper-gold mine reduced operating costs and raised recoveries and mill throughput, the **Eskay Creek** gold-silver mine completed a mill expansion and raised production, and **Highland Valley Copper** reduced operating costs and established production records. A successful season of mining and heap leach processing took place at the **Golden Bear** gold mine, but leach ore is now essentially exhausted.

Optimism is high that 2001 will be a better year for exploration in British Columbia. This is due to several exciting new polymetallic discoveries made late in 2000 and renewed interest by companies in base-metals. The federal government's new Exploration Investment Tax Credit should support junior companies' efforts to finance work, particularly when combined with the BC Mining Exploration Tax Credit, which was amended in July to include a flow-through component.

Mike Cathro
Regional Geologist, Kamloops

TABLE OF CONTENTS

FOREWORD ..... *iii*

PART A
OVERVIEW OF EXPLORATION ACTIVITY

NORTHWEST REGION
Summary 1
Metal Mines 3
Eskay Creek Mine 3
Endako Mine 3
Huckleberry Mine 3
Golden Bear Mine 4
Industrial Minerals and Gemstones 5
Placer Mining 5
Exploration Projects 6
Morrison 6
Whiting Creek 6
Lean-To 6
Chisholm Lake 6
Del Santo 6
Ascot 6
Telkwa 6
Surf Inlet 6
Hope 7
Laredo 7
Red Mountain 7
Praxis 7
WR 7
Mountain Boy 7
RDN 7
Silvertip 7
Thorn 7
Mansfield 7
Acknowledgments 8

NORTHEAST-CENTRAL REGION
Summary 9
Metal Mines 9
Kemess 9
Mount Polley 10
Gibraltar 11
QR Mine 11
Shasta 11
Baker 11
Industrial Minerals Operations 13
Coal Mines 13
Quintette 13
Bullmoose 13
Development Projects 13
Willow Creek 14
Exploration Trends 14
Exploration Summary 14
Gataga/Kechika Trough 14
Toodoggone Camp 15
Omineca Mountains 15
Rocky Mountain Foothills/Northeast Coal Block 17
Nechako Plateau 18
Cariboo 18
Likely and Horsefly Areas 20
Preliminary Report on Placer Activity 21
Other Information 23
Outlook 23
Acknowledgments 23
References 23

SOUTHWEST REGION
Introduction 25
Highlights 25
Exploration and Production Trends 25
Producing Mines and Quarries 26
Myra Falls Operation 27
Quinsam Coal 28
Limestone Quarries 28
Dimension Stone Quarries 28
Other Industrial Minerals 29
Exploration Activity 29
Vancouver and Inshore Islands 29
Pem 100 29
Nimpkish 29
Privateer 29
Raven 30
McTush 30
Valentine Mountain 30
Bolivar/Yew 30
Prospector Activity 31
Prospectors Assistance Program 31
Lower Mainland 31
Port Douglas 31
Harrison Lake - Hope Area 31
Prospectors Assistance Program 31
Acknowledgments 32

SOUTH-CENTRAL REGION
Summary 33
Exploration Trends 33
Mines 33
Highland Valley Copper 33
Harper Ranch 34
Falkland 34
Buse Lake 34
Pavilion 34
Craigmont 36

SOUTH-CENTRAL REGION cont.
Red Lake 36
Bud 36
Z1, Z2 36
Nipple Mountain 36
Canyon 36
Gemini 36
Similco 36
Blackdome 37
Development Projects 37
Ashcroft 37
Zeo 37
Tulameen 37
Prosperity 37
Getty North 37
Lumby 38
Exploration Projects 38
Stratiform Base-Metal Targets 38
Prophyry and Related Targets 39
Vein Targets 40
Magmatic Targets 40
Acknowledgments 41
References 41

KOOTENAY REGION
Summary 43
Exploration Highlights 43
Metals 47
Purcell Anticlinorium 47
Other Metal Projects 48
Industrial Minerals 50
Coal 52
Producing Mines and Quarries 52
Coal 52
Metals 53
Industrial Minerals 53
Acknowledgments 53

PART B
COALBED METHANE

Barry Ryan: An Introduction to Coalbed Methane Potential in British Columbia 55

MOUNT FLEET ALKALINE COMPLEX

Ian C.L. Webster and Gerry E. Ray:
The Mount Fleet Alkaline Complex (92I/16): A Potential PGE Target 71

PROSPECTORS ASSISTANCE PROGRAM

Garry Payie:
1999-2000 British Columbia Prospectors Assistance Program 77

PART A

REVIEW OF EXPLORATION AND MINING ACTIVITY

NORTHWEST REGION

By Paul Wojdak, P. Geo.
Regional Geologist, Smithers

SUMMARY

Five mines operated during the year. Eskay Creek mine expanded mill capacity and increased gold and silver production but did not discover any new mineralized zones in its ongoing exploration program. Huckleberry mine produced copper ore from the new Main zone pit but the grade is lower than the East starter pit so copper production decreased. Endako mine lowered production cost by operating an in-pit crusher but may be unable to stave off closure due to the low price of molybdenum. Golden Bear mine completed the Ursa pit and accelerated mining of the Kodiak B deposit to achieve record gold output. However, heap-leach reserves are exhausted and the mine will close in 2002. Closed since 1992, Cassiar mine resumed production of chrysotile asbestos but, with start-up difficulties seemingly overcome, the rebuilt mill was destroyed by a fire during a Christmas shutdown.

Major drilling programs were carried out at Eskay Creek mine, the Morrison porphyry copper prospect and the Silvertip silver-lead-zinc manto deposit. A ground geophysical survey completed on the RDN property sought an Eskay Creek-type massive sulphide deposit signature; drilling is anticipated in 2001. Drill targets were also established on the Thorn epithermal precious metal property through discovery of new showings and based on results of an airborne geophysical survey. The Chisholm Lake porphyry copper project was optioned by the Hunter Dickinson Group which performed geochemical and geophysical surveys.

Exploration spending in the Northwest was $6.5 million, a modest increase from 1999 but much lower than in the previous ten years (see Figure 1). Exploration drilling, an indicator of work on advanced properties, also showed a modest increase to 31 735 metres, but is far below the average of recent years (see Figure 2). Grassroots activity continued to languish. For the fourth successive year, the number of mineral claim units in good standing decreased as forfeitures exceeded new claims by 3195 units (see Figure 3). Major exploration projects are listed in Table 1 and their locations shown in Figure 4.

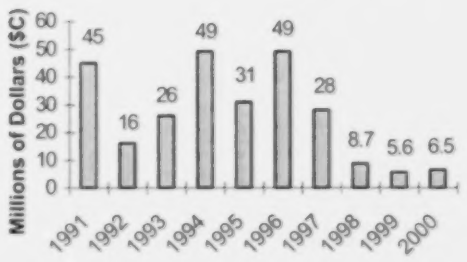


Figure 1. Mineral exploration expenditures in Northwest British Columbia.

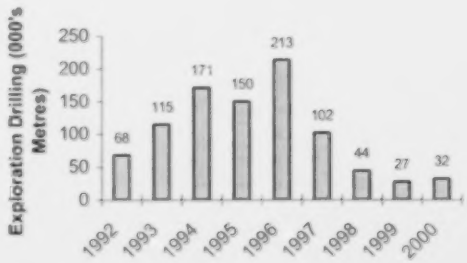


Figure 2. Exploration drilling in Northwest British Columbia.

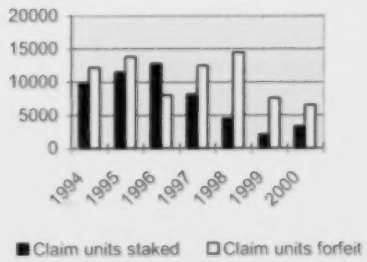
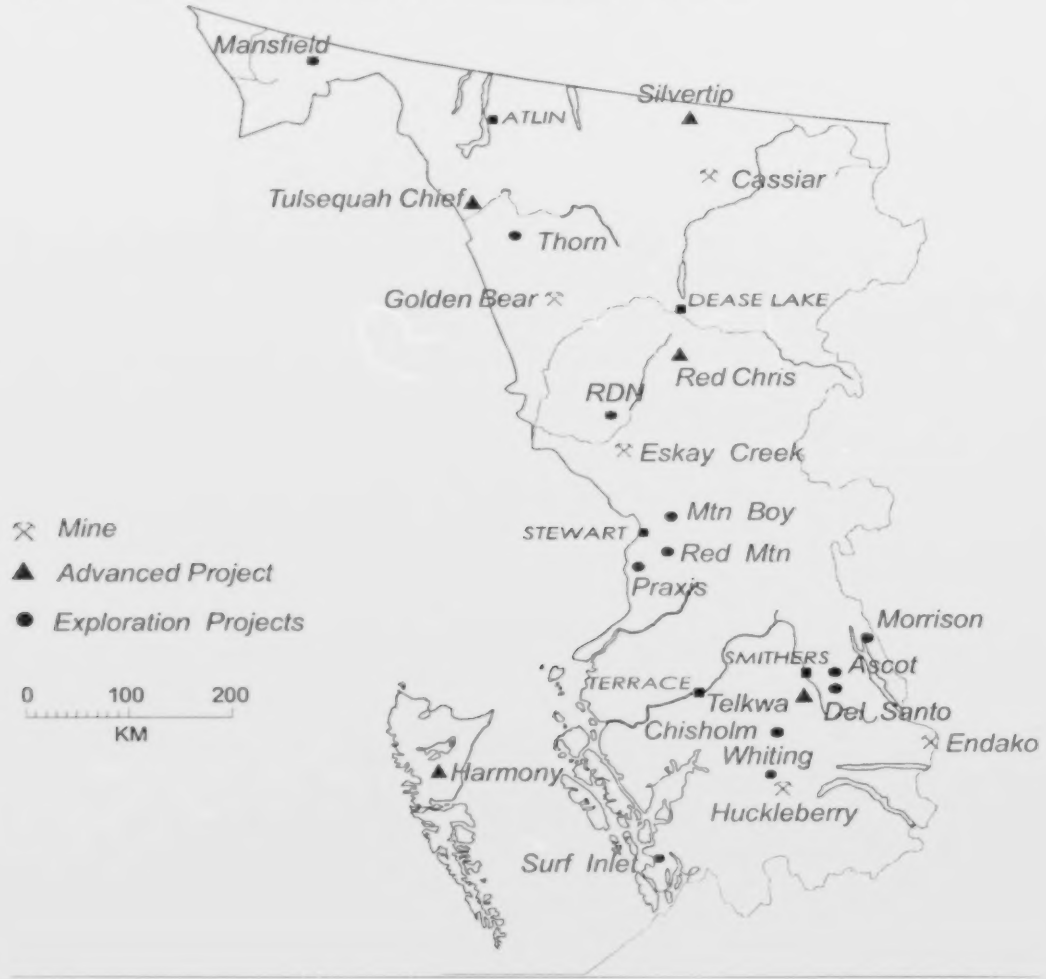


Figure 3. Claim activity summary, Northwest British Columbia.

Table 1. Major Exploration Projects, 2000

Property	Operator	MINFILE	NTS	Commodities	Deposit Type	Work Done
Eskay Creek	Homestake Canada Inc.	104B 008	104B/9	Au, Ag	Epithermal VMS	Drill access, 250 m; 51 ddh, 22 080 m
Huckleberry	Huckleberry Mines Ltd.	93E 037	93E/11	Cu, Mo	Porphyry	12 ddh, 1761 m
Morrison	Pacific Booker Minerals Inc.	93M 007	93M/1	Cu, Au	Porphyry	Trenching, 2000 m; 23 ddh, 6270 m
RDN	Rimfire Minerals Corp.	104G 144	104B/15, 104G/2	Au, Ag	Epithermal VMS	Geol; Grid, 30 km; Pulse EM & Mag, 30 km; Soil Geochem
Silvertip	Imperial Metals Corp.	104O 038	104O/16	Ag, Zn, Pb	Manto	22 Udh, 3210 m
Thorn	Rimfire Minerals Corp.	104K 031	104K/10	Au, Ag	Epithermal	Airborne EM-Mag, 385 km; Grid; Geol; Prosp; Soil geochem

Figure 4. Location map, mines and exploration projects in northwest British Columbia, 2000.



METAL MINES

The **Eskay Creek** underground gold-silver mine, owned by Homestake Canada Inc., developed new stopes, expanded the mill and began construction of a new tailings disposal site while, once again, completing the largest exploration drilling program in the region. Metal production amounted to 10 363 kg (333 167 oz) of gold and 458 408 kg (14.7 million oz) of silver at a cost of about $155 per ounce of gold equivalent. There are 236 employees and contractors. The mine produced 105 150 tonnes (about 280 tpd) of ore from the 21B zone that grade 80.2 g/t gold and 3512 g/t silver and was shipped directly to smelters in Japan and Quebec. Mill ore from the NEX, HW, 109 and, beginning in 2000, the 21C zones amounted to 87 527 tonnes that averaged 32.1 g/t gold and 1263 g/t silver. The mill, which produces a bulk sulphide concentrate, was enlarged from 200 to 250 tonnes per day. Mill recoveries were 92.7% for gold and 95.1% for silver.

The 21B zone is a moderately dipping stratiform sheet composed of sulphosalt and sulphide beds at the base of the contact mudstone. The NEX zone is the northern extension of this stratiform ore which, together with hanging wall ore beds in the HW zone, comprise a series of complexly folded and faulted lenses in the core of a north plunging anticline. New mill ore stopes were developed in NEX and HW zones as the main decline ramp was deepened. Ore from these high grade zones was blended with lower grade ore from the 109 and 21C zones in the footwall rhyolite. Definition drilling of southern 21C encountered high water flow that will make it more difficult to mine. The 21C zone consists of disseminated gold-silver ore in a gently plunging, rod-shaped body within rhyolite that underlies the contact mudstone. A new pipeline to a larger tailings disposal site in Tom MacKay Lake is under construction and will be operational in 2001. Reserves at Eskay Creek mine on January 1, 2001 comprise 705 200 tonnes of direct shipping ore containing 65.5 g/t gold and 3036 g/t silver, and 761 800 tonnes of mill ore grading 25.8 g/t gold and 1092 g/t silver. Mineral resources, primarily in the 21C zone, stand at 420 000 tonnes that grades 12.9 g/t gold and 405 g/t silver.

Exploration drilling at Eskay Creek focused on the north plunge of the Eskay anticline in search of other exhalative ore lenses. The area of best potential appears to lie between the Pumphouse and Andesite Creek faults where the contact mudstone is thickest and the altered rhyolite is best developed. The mudstone horizon on the east and west limbs of the fold was also tested by drilling.

At the **Endako** open pit molybdenum mine, Thompson Creek Mining Ltd. continued to focus on minimizing operating costs to offset the two-year price slump for molybdenum. The mill treated 9 217 853 tonnes of ore containing 0.0693% Mo and yielding 4 949 239 kg of Mo metal as float concentrate. The metal is sold as molybdic oxide and ultra pure molybdenum sulphide. Production increased from the previous year as a result of higher grade mill feed and a full 12 months of operation (the mine shut down for one month in 1999). Low haulage cost was achieved by mining from the shallow Denak West pit, mining the south wall of the Endako pit and recovering ore from the low-grade stockpile. Denak West ore did not contain an anticipated elevated lead content which would have been deleterious to concentrate quality. In October, an in-pit crusher began operation on the 798 metre bench of the Endako pit. It delivers ore to the mill via a 700 metre conveyor which climbs the north wall of the pit. By December, the new crusher and a reduction in the amount of stripping contributed to the lowest production cost ever achieved at Endako. Despite this Thompson Creek notified the mine's 199 employees that Endako could close in May, 2001, unless the price of molybdenum rises. Temporary provisions continue for a reduced power rate and other cost savings that were negotiated in 1999 under the auspices of the British Columbia Job Protection Commission.

The **Huckleberry** porphyry copper mine produced ore from a new open pit developed in the Main zone following two years of mining in the East starter pit. The mine, operated by Imperial Metals Corporation, employs 204 workers and is located 122 kilometres south of Houston. Cost reduction arrangements facilitated by the Job Protection Commission expired, reducing the mine's ability to repay its debt. A pebble crushing circuit which cost $3.4 million was installed to increase mill capacity from 19 000 to 21 000 tonnes per day. The mill treated about 7 145 600 tonnes, all from the Main zone, which graded 0.502% Cu. Metal production amounted to 33 489 370 kg of copper, 596,290 kg of molybdenum, 344 kg of gold and 8590 kg of silver. Production costs (operating plus capital but excluding transportation and smelting) were US$0.54 per pound of copper. About 1.4 million tonnes more ore than predicted from exploration data was delineated by blast holes at the north end of the Main pit. Although most of the Main zone was re-drilled in the 1990's, the north end was defined by older holes that

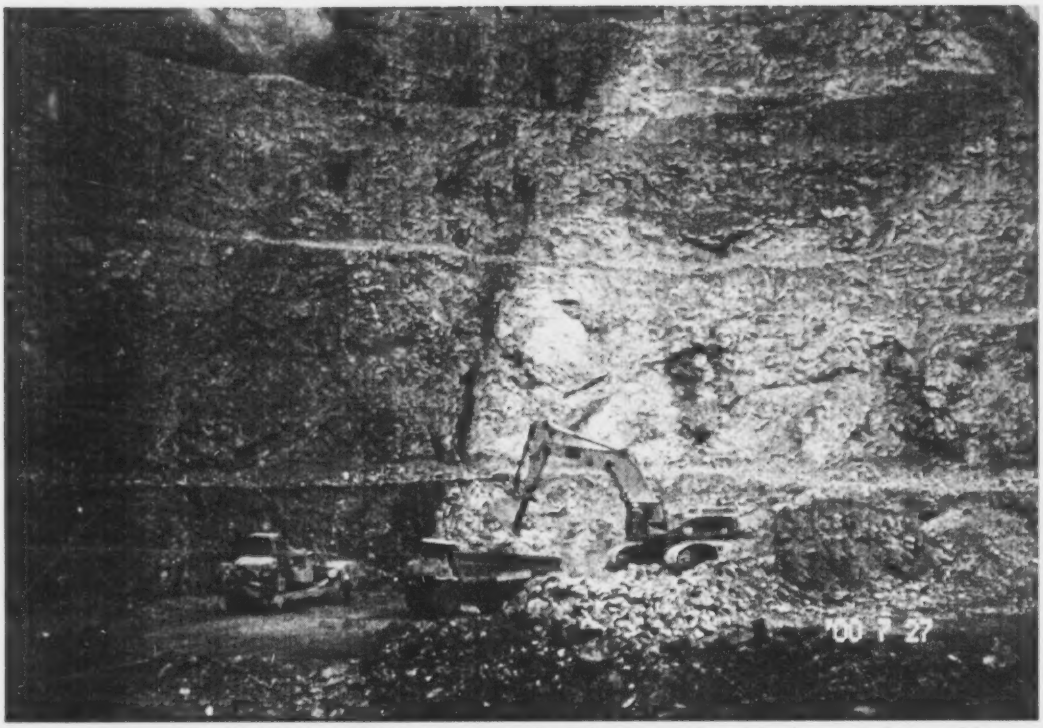


Figure 5. The Ursa fault sets gold-bearing graphitic limestone against light-coloured cherty dolomite near the bottom of the Ursa pit. Orientation of the Ursa fault changes upward from steep west dipping, as shown here, to steeply east near the surface.

did not recover all the fracture-controlled chalcopyrite, leading to an underestimation of reserves. Drilling on the northeast and southeast periphery of the East ore body encountered moderately long mineralized intercepts. As a result, the company made modest revision to ore reserves and adjusted the design of the East zone ultimate pit. Reserves in Main and East zones on December 31 2000 are 56 498 000 tonnes grading 0.494% Cu, 0.014% Mo, 0.059 g/t Au and 2.805 g/t Ag. A glacial dispersion study of the Huckleberry area by V. A. Levson of the British Columbia Geological Survey found copper-bearing granodiorite boulders 2 kilometres west of the Main zone. The source might be an undiscovered mineralized zone lying along the east-west trend of intrusions and mineralization at Huckleberry, or could simply represent glacial dispersion from the Main zone. Exploratory drilling will test the area west of the tailings pond early in 2001.

The **Golden Bear** heap-leach gold mine produced 2939 kg (94 500 oz) of gold for Wheaton River Minerals Ltd. at a cost of $180 per ounce. The mine operated from April until November with up to 120 workers. The company completed mining of the Ursa open pit and accelerated underground mining of the Kodiak B deposit. Although development only had been scheduled for this year, the company mined out the Kodiak B deposit. The Ursa pit produced 295 026 tonnes of ore containing 8.3 g/t Au that was crushed and stacked on the Totem heap leach pad. The ore consists of graphitic limestone that was brecciated, decalcified and mineralized with gold near the Ursa fault (see Figure 5). The Kodiak B deposit occurs in siliceous dolomite along the Fleece fault and is cut by a narrow, strongly clay-altered intermediate dike. Poor heap leach recovery is realized from ore mined close to the dike. The ore zone was developed by a decline and 185 181 tonnes extracted from four sub-levels. Of this, 85 581 tonnes grading 7.2 g/t Au was placed on the heap leach pad and the remainder, 99 600 tonnes containing 10.0 g/t Au, was stockpiled at the portal to be crushed and trucked to the leach pad next season. Underground evaluation of the Kodiak C deposit, a resource of 276 000 tonnes containing 7.8 g/t Au, determined

that gold recovery by leaching is too low to warrant mining. There are no plans to mine Kodiak C or other refractory gold resources in the Grizzly zone at Golden Bear.

INDUSTRIAL MINERALS AND GEMSTONES

At **Cassiar**, the refurbished mill of Cassiar Magnesium Inc. was destroyed by a tragic fire on December 25, 2000 during a Christmas-period shutdown. Cause of the fire is under investigation. The mill began production of chrysotile asbestos in January 2000 and, except for one month, it operated throughout the year and employed up to 65 people. The ore came from stockpiles left by Cassiar Mining Corporation which closed in 1992. These comprise about 2.4 million tonnes of talus in the Cirque dump that contains 7% recoverable fiber, 2.5 million tonnes of rock reject (at the former crusher site at the edge of the open pit) that yields 2% fiber, and 300 000 tonnes at two aerial tram stations (beside the old crusher site) with 8 to 10% recoverable fiber.

Stockpile material was up-graded by screening and the company trucked 220 000 tonnes to supplement the mill stockpile for winter operation. At first, only high fiber grade was recovered but by mid-year the mill operated as designed and produced the full range of former Cassiar grades (AK, AX, AY and AZ). Output increased steadily from 45 to 80 tonnes of bagged fiber per day. Total production amounted to 11 749 tonnes from a mill throughput of 222 248 tonnes. The company described product acceptance as excellent, with shipments to traditional and new customers in the Middle East, India and southeast Asia. Customer orders were sufficient for the sale of all anticipated 2001 production.

Nephrite jade was mined from three localities in the Turnagain River area east of Dease Lake. About five percent of the material mined is gemstone quality. The Jade West Group shipped about 100 tonnes from the **Jadex** deposit (104I 078) and 65 tonnes from the **Polar** deposit (104I 083). Jedway Enterprises Ltd. produced about 35 tonnes from the **Blue Jay** claim.

PLACER MINING

by Daryl Hanson, P. Eng. (Geol)

Placer gold production in the Northwest Region decreased significantly from 1999 levels. Mining activity increased in the McDame Creek area of the Liard Mining Division but decreased in the Atlin Mining Division. Three principal factors contributed to the overall decrease: low gold prices, high fuel costs, and scarcity of shallow pay dirt. Approximately 125 kilograms (4000 oz) of gold was produced from 30 mining operations with a total of 67 seasonal workers. There were 30 mining projects and 44 exploration programs granted permits during the year.

In the Atlin district, work continued to concentrate on the historic creeks in the camp. On **Wright Creek**, Sisters Resources Ltd. finished mining a channel that was discovered in 1998. The company also continued its exploration efforts by test pitting and rotary drilling between the recent workings and Surprise Lake. No economic leads were discovered and there are no plans to continue mining on this creek. On **Ruby Creek**, Ruby Gold Ltd. continued stripping Quaternary basalt on the east side of the valley and mined underlying Tertiary gravel. Fat Chance Placer Inc. continued to have success mining high-grade, orange colored (Tertiary?) gravel on the west bedrock rim of **Boulder Creek**. On **Wilson Creek** Gary Crawford and Peter Burjoski continued to strip the 30 metres of overburden that overlies a deep channel that was located by drilling. It appears, unfortunately, that the pit was not centered on the channel and therefore no pay dirt was encountered. **Spruce Creek** was only modestly active in 2000. Daniel Johnson designed and built a large "New Zealand" floating plant which he used to mine a section of high-grade paleochannel gravels that is laced with old underground workings. R&L Godkin Contractors Ltd. in conjunction with West Coast Paving Co. Ltd. developed two small truck/excavator pits on the south side of the creek near the confluence with **Little Spruce Creek**. On **Pine Creek**, Sisters Resources Ltd. developed two pits, trying unsuccessfully to extend the south and east margins of the previously mined Gold Run pit. Efforts by Sisters Resources also failed to develop an economic operation on **Snake Creek**. Bruce Wrightson continued to mine high-grade paleochannel gravels along the northern bedrock rim of **McKee Creek**. Among the smaller projects, the most significant were those by Bryan Bjork on two tributaries of **Fox Creek** and the uneconomical attempt by Arrow Minerals Ltd. to reprocess old tailings on **Otter Creek**.

Only one major project in the Atlin district was on a creek without historic production. Turn Creek Resources Ltd. completed an extensive program of test pits on **Turn Creek**, where they explored for

shallow gold bearing gravels. The program failed to identify any areas suitable for immediate development.

Most of the increased activity in the Liard Mining Division was along historic **McDame Creek** and its tributaries, including **3rd North Fork**, **Troutline** and **Snowy Creeks**. Jerry Unrau, Delbert Batke, and Harvey Friesen all worked parts of the old Centerville leases with varying degrees of success and Scott Jamieson did a limited amount of mining at Hollaway Bar. Raymond Adams continued aggressive exploration of his holdings near the Cassiar Junction. Elsewhere in the mining division, Michael Swenson continued systematic mining on **Dease Creek**; Ed Asp developed a new pit on **Goldpan Creek**; and Renald Bergeron initiated an ambitious mining plan on **Dennis Creek**.

EXPLORATION PROJECTS

Pacific Booker Minerals Inc. drilled 17 holes and deepened 2 of its previous core holes on the **Morrison** porphyry copper prospect (93M 007). The company can earn a 50% interest in the property from Noranda Inc. by advancing the project to a bankable feasibility study within four years with expenditure of $2.6 million. Chalcopyrite and minor bornite occur as disseminations and fracture fillings in an Eocene biotite-hornblende-plagioclase phyric stock. Previous exploration at Morrison determined that the copper grade is strongly zoned around the low grade core of the stock and the deposit is cut by a strike-slip fault. An originally concentric zone containing better than 0.5% Cu is bisected and offset about 300 metres resulting in a sinuous body about 1000 metres long (CIM Special Volume 46). Drilling by Pacific Booker improved definition of this higher grade zone, especially to depth, and tested for extensions to the west and northwest. Morrison has an indicated and inferred resource, calculated prior to drilling by Pacific Booker, of 190 million tonnes of 0.40% Cu and 0.2 g/t Au.

Huckleberry Mines Ltd. explored a new target within the large **Whiting Creek** porphyry prospect (93E 050), 7 km north of Huckleberry mine. Mineralization is associated with Late Cretaceous stocks that cut Hazelton Group volcanic strata. Chargeability and magnetic response data were interpreted to indicate a mineralized intrusion between the previously drilled Ridge molybdenum zone and the Creek copper-molybdenum zone. Four holes were drilled through 20 to 30 metres of till into coarse grained quartz monzonite, that is cut by a weak stockwork of quartz-chalcopyrite-molybdenite veins with epidote-gypsum gangue. Weak propylitic alteration characterizes the intrusion. On the **Lean-To** showing (93E 105) eight kilometres southeast of Huckleberry, Rupert Seel excavated trenches to expose a chalcopyrite-cemented breccia in another Cretaceous stock.

Prospectors Ed and Gerry Westgarde optioned their claims near **Chisholm Lake**, 45 kilometres southwest of Houston, to the Hunter Dickinson Group Inc. which commenced a 60 kilometre grid IP and soil geochemical survey very late in the year. Porphyry copper mineralization occurs in granodiorite outcrop and boulders near a logging road. Imperial Metals Corporation drilled percussion holes along the logging road in 1998 but did not locate significant mineralization and dropped their option of the property in 1999. The prospectors found another bedrock copper occurrence 1.5 kilometres from the area targeted by Imperial Metals that prompted Hunter Dickinson Group to acquire the claims and expand the search area (D. Johnson, pers. comm.).

Two volcanogenic massive sulphide prospects southeast of Smithers received limited exploration. Both are in the Nilkitkwa Formation of the Hazelton Group. The larger program was at the **Del Santo** (93L 025) property, where Telkwa Gold Corp. performed magnetic and gravity surveys, followed by diamond drilling aimed at extending the stratiform chalcopyrite-magnetite-sphalerite showings. Only magnetic basalt was intersected (W. Tompson, pers. comm.). On the **Ascot** property (93L 024), Equity Engineering Ltd. tested the continuity and thickness of sphalerite-barite beds in limy to argillaceous felsic tuff with two short packsack drill holes. The mineralization was discovered by trenching in 1988 but was not drilled before. No results have been disclosed.

Luscar Ltd. announced that the **Telkwa** coal project is on hold, due to the low price of thermal coal on the international market. The Project Report, anticipated for the past year, and required by government's Environmental Assessment process to gain project approval, will not be submitted. The company will retain its coal licenses.

On Princess Royal Island, Kermode Resources Ltd. and Rupert Resources Ltd. drilled two underground holes below the lowest level of the **Surf Inlet** (103H 027) mine, the same area as they tested in 1997. Two quartz veins were intersected but the company did not announce any assay results. Telkwa

Rose Minerals Ltd. canceled the planned mining of a bulk sample from the **Hope** gold-quartz vein near Kalum Lake, north of Terrace. Some specimen material of free gold was extracted.

Feasibility studies stalled on a proposed 450,000 tonne per year marble quarry at the **Laredo** deposit (103A 001) on Aristazabal Island. The proponent, Orinda Investments Limited, was reorganized and re-financed during year 2000. They plan to extract a bulk sample of high purity calcium carbonate filler in 2001 and apply to begin commercial production.

Wheaton River Minerals Ltd. purchased the **Red Mountain** gold project (103P 086) from the receiver of Royal Oak Mines Inc. for $413 360. Wheaton River re-logged drill core from four sections and confirmed that the gold zone is on the margin of a large raft of turbidite siltstone enclosed by two distinct phases of hornblende-feldspar porphyritic diorite of the Goldslide intrusions (A. Hamilton, pers. comm.). Alteration studies and structural analysis were undertaken to gain a better understanding of ore controls and enable ore reserves to be recalculated. An aerial survey examined the route for an access road up rugged Bitter Creek valley to the portal of the Marc zone. A pre-feasibility study is in progress.

CSS Exploration, a private company, acquired the **Praxis** claims 25 kilometres south of Stewart. The company will explore middle Jurassic rhyolite, correlative with Eskay Creek strata, for a precious metal-enriched massive sulphide deposit. The favourable stratigraphy was recognized during recent mapping by C. A. Evenchick of the Geological Survey of Canada. The company conducted 230 line kilometres of airborne electromagnetic surveying, detailed stream silt geochemistry and geological mapping. In another grassroots program, Teck Explorations Ltd. examined and sampled mineral showings on its newly-acquired **WR** claims 20 kilometres southeast of Stewart.

Mountain Boy Minerals Ltd. shipped 34.5 tonnes of silver ore to the Trail smelter from the High Grade vein on the **Mountain Boy** property (104A 011), 22 kilometres north of Stewart. A shipment in 1999 contained 18 800 g/t silver. Sphalerite, galena, argentite, native silver, stromeyerite and pyrargyrite occur in a gangue of quartz, jasper and barite. A proposed drilling program was deferred until 2001.

Rimfire Minerals Corp. optioned the **RDN** property (104G 144) to Newmont Exploration of Canada Limited. RDN is underlain by Jurassic stratigraphy that is correlative with Eskay Creek strata. The property is located 40 kilometres south of the Eskay mine. An interpreted sea-floor hydrothermal vent and a gold-lead-arsenic-silver soil anomaly, are both associated with argillite that is underlain by felsic volcanic rocks and overlain by pillow basalt. A UTEM geophysical survey located six significant conductors over a 6.7 kilometre strike length. Drilling is anticipated in 2001.

Underground drilling was conducted at the **Silvertip** limestone-hosted silver-lead-zinc prospect (104O 038) by Peruvian Gold Ltd. and Imperial Metals Corp. The program tested the continuity and orientation of a 31.4 metre massive sulphide zone intersected in a surface drill hole, reported in *Exploration and Mining in British Columbia - 1999*. Drilling delineated a 5 to 20 metre thick massive sulphide zone with grades that are typical of the deposit (*i.e.* 325 g/t silver, 6.4% lead, 8.8% zinc). The massive sulphide body is roughly stratabound. It is interpreted by the company to be an important mineralizing conduit, but not a chimney deposit.

Rimfire Minerals Corp. began exploration of the **Thorn** epithermal copper-gold-silver property, 125 kilometres northwest of Telegraph Creek, with an airborne geophysical survey. This was followed by soil geochemistry, geological mapping and prospecting. The property has been known since 1963 as one of few occurrences of enargite in British Columbia, but exploration has been sporadic due to its remote and rugged location. Pyrite-tetrahedrite-enargite veins and strong clay-sericite alteration are developed in a late Cretaceous quartz-feldspar-biotite stock (see Figure 6). The company reported assays from five veins, two of which were discovered in year 2000, that range widely in grade from 0.3 to 8.7% copper, 1.1 to 57.4 g/t gold and 90 to 760 g/t silver over 0.5 to 2.3 metres. Rimfire plans to test some of these veins by drilling in its next exploration program.

The **Mansfield** property (114P 031) of Santoy Resources Ltd., which is located at the south end of the Kluane mafic-ultramafic belt, 110 kilometres south of Haines Junction, was explored for platinum group metals. In the Kluane belt, ultramafic sills typically consist of clinopyroxenite, peridotite and marginal gabbro with, on the Wellgreen and Canalask properties in nearby Yukon, deposits of nickel and copper sulphides with significant platinum and palladium. The ultramafic sill on the Mansfield property is 50 metres wide and, as interpreted from

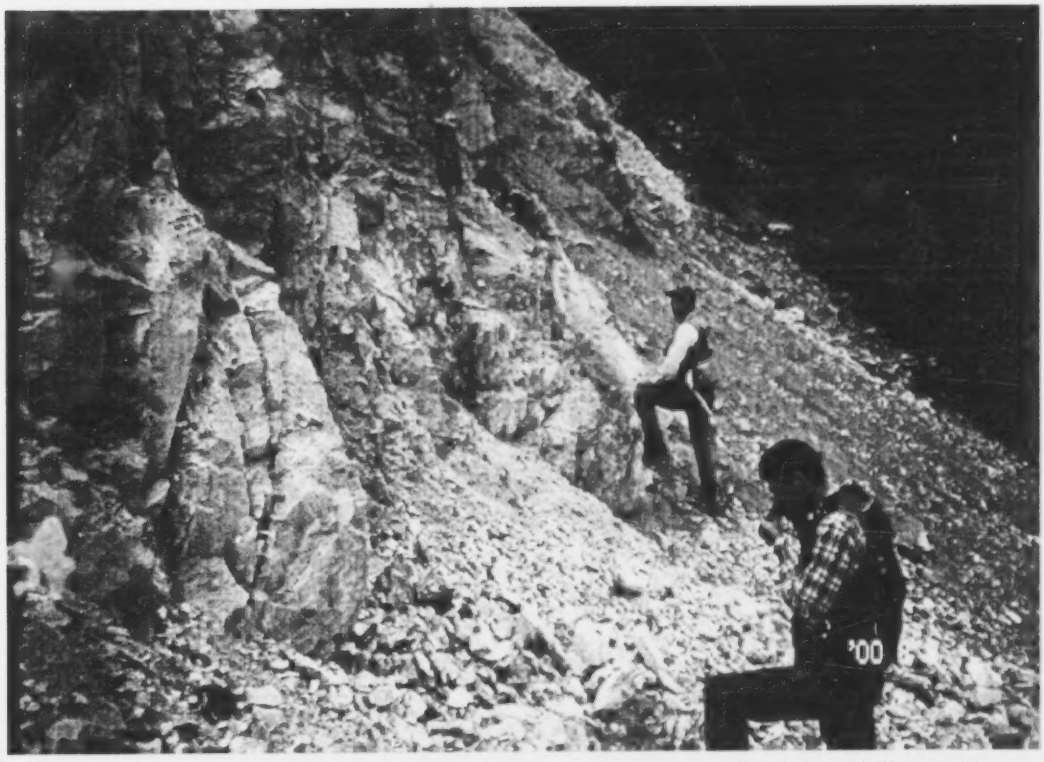


Figure 6. David Caulfield, president of Rimfire Minerals Corp. (right) and Tom Schroeter, British Columbia Geological Survey, examine intensely altered quartz-biotite-feldspar porphyry, the host to enargite-tetrahedrite veins on the Thorn property.

an airborne magnetic and electromagnetic survey flown in 1987, extends more than 13 kilometres beneath a thin blanket of glacial till. Secondary nickel-copper mineralization occurs in an iron carbonate altered basalt. Previous explorers trenched copper-nickel soil anomalies but did not investigate areas where soil samples contain up to 910 ppb palladium and 260 ppb platinum. Santoy prospected bedrock canyons and dug soil pits through glacial till in search of platinum group metals.

ACKNOWLEDGEMENTS

I sincerely thank prospectors, geologists and mine staff for their hospitality while visiting their projects. And I greatly appreciate the assistance of Smithers Mines office in preparing this report.

NORTHEAST– CENTRAL REGION

By Robert A. Lane, P. Geo.
Regional Geologist, Prince George

SUMMARY

In 2000, exploration activity in the Northeast-Central region rebounded sharply from the record lows of 1999. Exploration expenditures were up more than 80% and the amount of diamond drilling more than doubled. Discovery of the Bonanza Ledge high grade gold zone by International Wayside Gold Mines Ltd. was the region's most significant exploration highlight. It led to the largest staking rush the province has witnessed since the discovery of Eskay Creek in 1989. Successful infill drilling at the Sustut copper deposit by Doublestar Resources Ltd. led to a revised "drill-indicated" resource for a proposed starter pit, and plans for further detailed exploration in 2001. A major exploration drilling program at the Lustdust polymetallic prospect by Alpha Gold Corp. produced very encouraging results. Hudson Bay Exploration and Development Company Limited completed phase one of a broad, multidisciplinary program on its Lottie Lake volcanogenic massive sulphide property. Several grassroots programs resulted in discoveries of vein, porphyry and volcanogenic massive sulphide showings that continue to demonstrate the unrealized mineral potential of the region.

Mining companies endured another year of subdued commodity prices and the Northeast Coal Block suffered a major setback with permanent closure of the Quintette mine in August. The shut down resulted in the loss of some 500 direct jobs. The Bullmoose operation benefited in the short term with a modest increase in production. On a more positive note, Pine Valley Coal Ltd. initiated a bulk sampling program at its Willow Creek deposit. Coal exploration in the northeast was relatively quiet with Western Canadian Coal Corp. the only company evaluating ground; however, the potential of the area for coalbed methane is being examined.

At the Kemess gold-copper mine, owner/operator Northgate Exploration Ltd. realized significantly higher throughput, markedly improved metal recoveries and lower average cash costs. Imperial Metals Corporation managed to keep its Mount Polley copper-gold mine operating despite expiration of a Job Protection Commission agreement in the middle of the year. Significant drilling programs took place at Kemess and Mount Polley, the two major operating metal mines in the region. Mine site exploration, including important programs at the idle Gibraltar and Baker mine sites, also was up markedly compared to 1999 levels.

The year 2000 was, for the most part, a year of recovery. Many indicators suggest that the rebound will continue during 2001.

METAL MINES

The **Kemess** open-pit gold-copper mine (Photo 1), located 300 kilometres northwest of Mackenzie (Figure 1), is owned and operated by Northgate Exploration Ltd. The mine employs approximately 445 people. In 2000, the company invested about $37 million to upgrade its operation. Installation of a new conventional thickener, rebuilds of both concentrate filter presses, modifications to flotation cells and full-time use of the regrind circuit has led to significant increases in metal recoveries in the mill. Also, addition of four new haul trucks, which brings the fleet of 240-tonne trucks to eleven, enabled the operation to reach or exceed its designed mill throughput of 48 000 tonnes per day. Metal recoveries for the fourth quarter increased dramatically over the first and second quarters to about 68% for gold and 75% for copper. Data for October showed that the cost of producing an ounce of gold had dropped to US$170, down from the third-quarter average of US$231. All the changes mentioned were in place by September and further improvements in productivity are expected in 2001. Production for the year and mineable reserves for the Kemess South orebody are listed in Table 1. The porphyry deposit is hosted by the Maple Leaf stock, a body of Early Jurassic quartz monzonite that intrudes intermediate volcanic rocks of the Jurassic Toodoggone formation. Hypogene, supergene, transitional and leach cap ore types are mined and milled separately because of their distinctive milling characteristics.

In 2000, Northgate began to explore the large tenure block that encloses its Kemess South deposit.

Photo 1. Looking westerly over the Kemess South orebody with waste rock dump in background. Two 240-tonne haul trucks in foreground provide scale (photograph taken by Ed Pittman, Inspector of Mines, Prince George).

Two priority porphyry gold-copper targets, Kemess North and Kemess Centre, were evaluated. A 12-hole, 4104-metre program of diamond drilling tested the Kemess North deposit, 5.5 kilometres north of the Kemess south pit. The new holes were drilled to confirm grade continuity between existing holes and to test new targets on the margin of the deposit. The most encouraging mineralization was intersected by holes drilled on the eastern side of Kemess North, where disseminations and stockworks of pyrite-chalcopyrite, locally associated with veins of quartz-anhydrite-magnetite, occur in propylitically-altered bladed feldspar porphyry and porphyritic monzodiorite. In January 2001, Northgate announced that the program had expanded the mineral inventory for the Kemess North zone to approximately 360 million tonnes grading 0.299 g/t Au and 0.154% Cu, up from the previous estimate of 74 million tonnes grading 0.343 g/t Au and 0.188% Cu. The company also drilled four holes, totalling 1015 meters, on its Kemess Centre prospect, a target located less than two kilometres north-northwest of the Kemess South pit. The first three holes tested an east-trending coincident radiometric - IP chargeability anomaly and intersected locally hornfelsed mafic flows and tuffaceous siltstones that are cut by a number of pale grey to pink quartz monzonite to diorite dykes. Mineralization encountered consists of disseminated and fracture-controlled pyrite, chalcopyrite and rare fracture-controlled molybdenum. The fourth hole is approximately 500 metres to the north and tested the eastern flank of a "bulls-eye" radiometric anomaly. It intersected mineralized and altered quartz monzonite to monzodiorite over its entire 319 metre length. The company intends to continue exploring both targets in 2001.

The **Mount Polley** porphyry copper-gold mine, located eight kilometres southwest of Likely, has a workforce of approximately 240. The mine is operated and 52.5%-owned by Imperial Metals Corporation. SC Minerals Canada Ltd., a wholly-owned subsidiary of Sumitomo Corporation of Japan, owns the remaining 47.5%. Mining took place mainly in the Cariboo pit, but approximately 10% of the mill feed came from the first two benches of the Bell pit. The

Springer zone has not yet been developed, but did receive a limited amount of percussion drilling (1670 metres in 39 holes). Extensive percussion and diamond drilling is planned for the Springer pit in 2001. Production for year 2000 (Table 1) totalled approximately 2.6 million grams (84 000 ounces) gold and 15 600 tonnes (34.4 million pounds) copper from 6 949 600 tonnes of ore processed at an average rate of 19 000 tonnes per calendar day. Metal recoveries for the same period were 69.75% for copper and 75.44% for gold. These rates have steadily increased since Mount Polley was commissioned in 1997. Mine staff have minimized the amount of oxide copper in the heads and mill-metallurgy staff have modified components in the concentrator. In June, the two-year economic plan arranged in co-operation with the province's Job Protection Commission expired and no extension was granted. Low metal prices continued to hamper the mine's profitability as it struggled to meet its scheduled loan repayments to Sumitomo Corporation. In January 2001, Imperial Metals signed an agreement with Sumitomo to purchase the minority interest in Mount Polley from SC Minerals Canada.

Mineralization at Mount Polley occurs in a northerly trending belt of hydrothermally altered intrusion breccia that is part of the Early Jurassic Polley stock. Exploration drilling programs this year targeted the C2 and 207 zones, which are immediately south of the Cariboo pit, the Road (or Rad) zone north of the Cariboo pit, and the new Southeast zone. The C-2 zone, and parallel 207 zone, have implications for future expansion of the southern limit of the Cariboo pit. Taken together, the zones have a strike length of at least 200 metres and are up to 70 metres across. Mineralization consists of disseminated and fracture-controlled chalcopyrite and trace bornite in hydrothermally altered intrusion breccia. Secondary K-feldspar, actinolite and magnetite are abundant. There are high copper oxide to sulphide ratios in the top 40 metres of the C2 and 207 zones which, at present, render the two zones subeconomic.

The Southeast zone, which measures 200 metres long by 150 metres wide, is a new exploration target located immediately southeast of the mine's major waste rock dump. Percussion drilling (4117 metres in 99 holes) and limited diamond drilling (411 metres in 3 holes) outlined approximately one million tonnes with an average grade of 0.65 g/t Au and 0.43% Cu. Mineralization occurs within a structurally controlled block of brecciated and intensely silicified monzonite. The zone is open to the south and east and will continue to be a priority target in 2001.

Taseko Mines Limited signed a memorandum of understanding with Cominco Engineering Services Ltd. (CESL) to investigate the feasibility of constructing a 35,000 tonne per year copper refinery at the presently idle **Gibraltar** mine. The refinery would utilize CESL's proprietary hydrometallurgical technology, an environmentally friendly process that is projected to lower the operating cost at Gibraltar by US$0.20 per pound of copper produced. A full feasibility study is expected to be completed by early 2001. In 2000, Taseko completed more than 200 line-kilometres of IP over areas north, south and east of existing pits and rock dumps. The survey generated a number of anomalies that the company will further evaluate in 2001.

Big Valley Resources (partnered with Dean Mason (CA), 568674 British Columbia Ltd. and several related companies from Prince George) has reached an agreement with Kinross Gold Corporation to purchase the former **QR** gold mine and property. The purchase price of $4.5 million is payable over 3 years commencing January 1, 2001. The new owners plan to process existing low grade ore stockpiles (approximately 220 000 tonnes grading 1.5 g/t Au) and to re-evaluate the underground Midwest zone for additional gold-bearing skarn mineralization. Big Valley also plans to explore the property aggressively for new open pitable resources. The most recent exploration drilling carried out by Kinross focused mainly on areas west of the developed zones and outlined limited resources in two areas. However, the best potential may exist east of the Main zone pit, where the permissive gold-bearing horizon thickens and comes close to surface. This area will likely be a priority for renewed exploration in 2001.

The **Shasta** epithermal vein deposit, located in the Toodoggone region of northern British Columbia, has been mined intermittently since 1989. In 2000, Sable Resources Ltd. mined and processed 8581 tonnes of gold-silver ore with an average head grade of approximately 10 grams/tonne gold equivalent. Blasted muck was retrieved from underground using a single scoop tram, then loaded onto a truck for the 10 km haul to the company's Baker mill. At the **Baker** mine itself, five closely spaced lines of Induced Polarization survey, completed on each of the past-producing A and B veins, identified possible extensions of the two mineralized structures. The survey also identified two new structures, northwest of and parallel to the B vein. Sable intends to drill these targets in 2001 and also expects to resume production at the Baker mine. This year, an eight-hole, 360-metre diamond drilling program on the Ridge

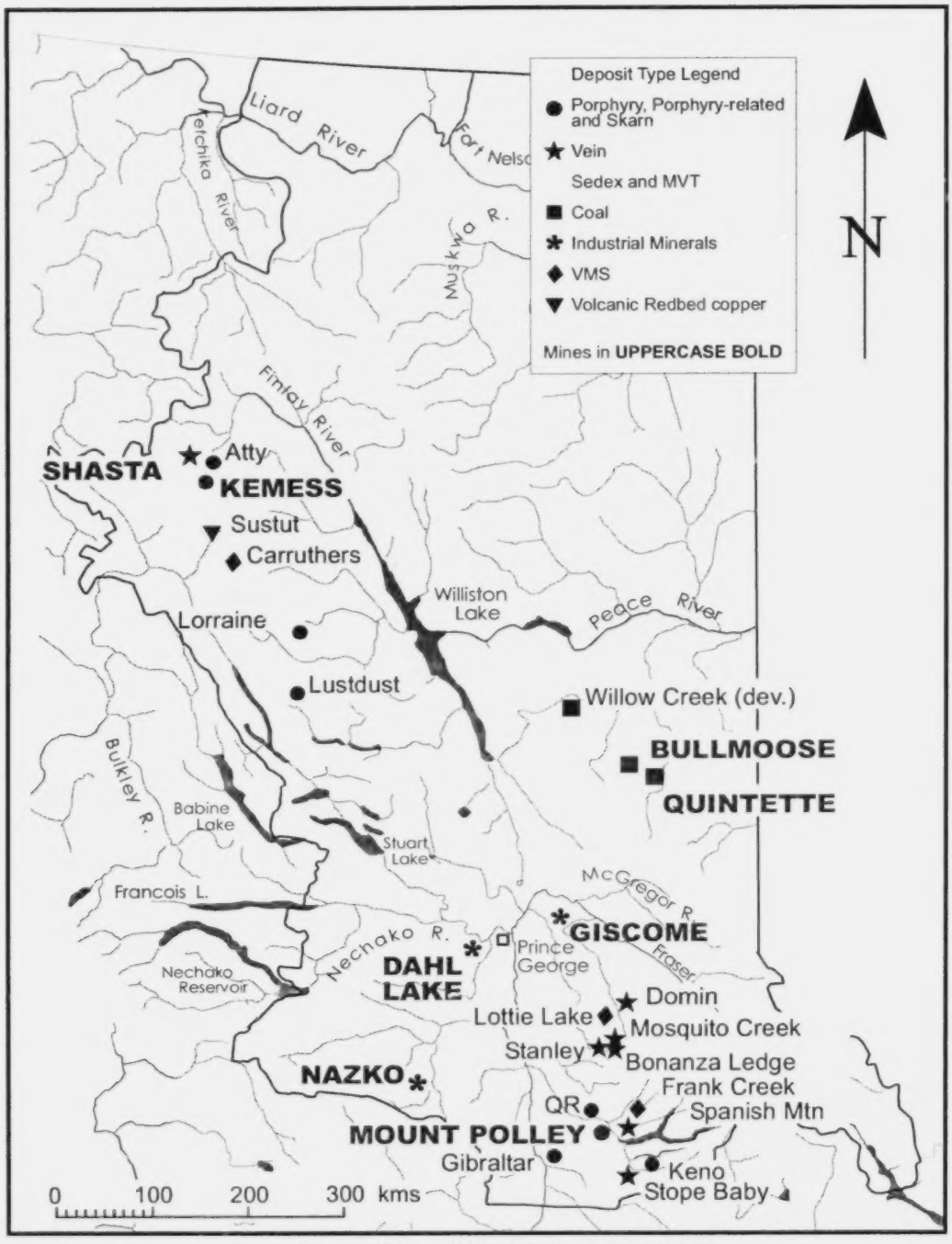


Figure 1. Operating Mines and Selected Exploration Projects, 2000.

zone targeted the Beck vein. However, there were no high grade intersections.

INDUSTRIAL MINERALS OPERATIONS

Canada Pumice Corporation produces red and black tephra from its **Nazko** quarry west of Quesnel. Current production is approximately 15 000 cubic metres annually. The deposit has a resource in excess of 44 million tonnes. The material from Nazko is used for landscaping, sporting facilities, growing and filtration media and lightweight aggregate (structural) applications. In 1999, the company bought the former Crownite plant site in Quesnel with the intention of developing a processing and bulk handling facility for its products. Canada Pumice is also evaluating the potential of its Burnt Shale pozzolan deposit, which is adjacent to the former plant site.

In the Prince George area, small quantities of crushed limestone were shipped from the Pacific Lime Products Ltd. **Giscome** quarry to supply local area pulp mills. Northrock Industries Ltd. provided a limited amount of limestone from its **Dahl Lake** quarry for local rip-rap and landscape uses. Dome Creek Structural Slate Company quarried a limited tonnage of attractive green slate from its Dome Creek deposit on Highway 16 east of Prince George.

COAL MINES

The year began with two operating metallurgical coal mines, both located near Tumbler Ridge in the northeast coal block. However, in March, Teck Corporation announced plans to permanently close its high-cost **Quintette** mine, resulting in the layoff of more than 500 workers. The mine ceased operations on August 17, 2000, after producing an estimated 1.3 million tonnes of clean metallurgical coal during the year. Coal prices, which have shrunk 28% over the last two years to about US$40/tonne, were cited as the primary reason for the closure. From its opening in 1984, Quintette produced approximately 68 million tonnes of metallurgical coal. There are currently about 50 staff on site de-commissioning the wash plant and conducting reclamation.

The **Bullmoose** mine, 61% owned by Teck Corporation, produced an estimated 1.7 million tonnes of clean metallurgical coal in year 2000. Production increased marginally from 1999 levels, in part, to maintain the company's coal supply obligations to its Japanese clients. The mine is expected to continue operating until June 2003, when reserves at the South Fork pit will be exhausted. The current workforce of approximately 250 is expected to be gradually reduced as the operation nears its closure date.

DEVELOPMENT PROJECTS

Pine Valley Coal Ltd. started to develop the low-volatile coal measures at its **Willow Creek** property, 45 kilometres west of Chetwynd. The deposit occurs

Table 1. 2000 Mine Production and Reserves

Mine (Operator)	Employment	Production	Reserves (as of Jan. 1, 2001)
Kemess (Northgate Exploration Ltd.)	445	7029 kg (225 994 oz) Au 7085 kg (227 812 oz) Ag 22 850 tonnes Cu	146 million tonnes grading 0.653 g/t Au and 0.235% Cu
Mount Polley (Imperial Metals Corp.)	243	2612 kg (83 998 oz) Au, 81.9 kg (2632 oz) Ag 15 627 tonnes Cu	23.0 million tonnes grading 0.443 g/t Au and 0.381% Cu
Shasta (Sable Resources Ltd.)	10	62 kg (2000 oz) Au-equiv (est)	-
Quintette (Teck Corp.)	500/50	1.3 million tonnes metallurgical coal (est)	Closed August, 2000
Bullmoose (Teck Corp.)	240	1.7 million tonnes metallurgical coal (est)	Production to continue at 1.7 million tonnes/year until mid-2003
Nazko (Canada Pumice Corp.)	4	15 000 m3 tephra (approx)	44 million tonnes

on the north limb of the Peace River anticline within the Cretaceous Gething Formation. The company, owned one-third by Mitsui Matsushima of Japan and two-thirds by Globaltex Industries Inc., plans to mine up to 100 000 tonnes of coal during the winter of 2000-2001 from the #7 seam in the Peninsula Pit. A simple 'crush-and-screen' process will be used to produce a 'raw' (i.e. unwashed) coal product for direct shipping. A rail siding has been constructed, a loadout facility was nearing completion at years end, and access/haul roads have been upgraded. If markets prove favourable for this coal product, which is used for pulverized coal injection (PCI) in blast furnaces, production is expected to increase over the next few years.

EXPLORATION TRENDS

Year 2000 exploration expenditures for the region were about $6.2 million (Figure 2), up more than 80% from last year. The amount of exploration drilling also increased sharply to 36 600 metres (Figure 3), in part reflecting renewed activity at the region's two major metal mines. Claim staking in the region increased dramatically, mainly because of activity in the Cariboo region. The number of Mineral Notices of Work (NoW) applications increased to 112 from only 86 in 1999, and the total number of NoW applications for all projects in the region rose by 45 to 568 (Table 2). There were twelve major projects (those that involved mechanical disturbance and expenditures in excess of $100,000; Table 3), two more than in 1999. The major projects were at Kemess, Mount Polley, Gibraltar, Mosquito Creek Gold, Spanish Mountain, Sustut, Bonanza Ledge, Carruthers, Domin, Lottie Lake, Lustdust and Stanley.

Gold-enriched porphyry systems, gold-bearing veins (including 'pyrite replacement' mineralization)

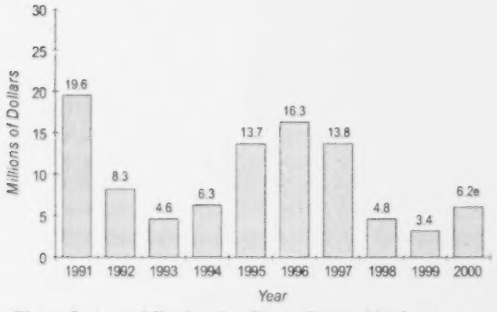


Figure 2. Annual Exploration Expenditures, Northeast-Central Region.

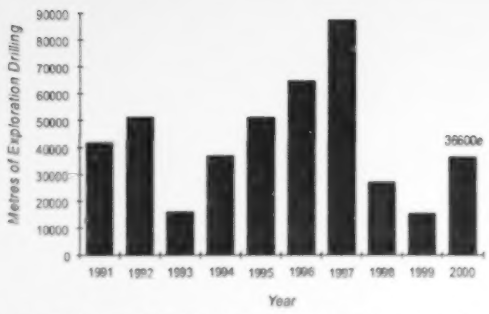


Figure 3. Annual Exploration Drilling, Northeast-Central Region.

Table 2. Notice of Work (NoW) Submittals for Projects in the Northeast-Central Region

Type of NoW	Year 1995	1996	1997	1998	1999	2000
Mineral	221	184	164	115	86	112
Placer	498	440	415	403	393	422
Coal	3	4	5	5	2	1
Other	67	58	57	56	42	33
Total	**789**	**686**	**641**	**579**	**523**	**568**

and volcanogenic massive sulphide deposits were the most sought after targets in 2000; together they accounted for more than 80% of exploration spending in the region (Figure 4). Several senior and junior companies are following up their research with 'old fashioned', grassroots reconnaissance programs. Primary targets are porphyry, vein and volcanogenic massive sulphide systems. Some of this grassroots work will lead to more advanced stage exploration. The province's Prospectors Assistance Program provided grants for seven individuals to explore in the region. These grantees located a number of new showings that warrant additional work.

EXPLORATION SUMMARY

GATAGA/KECHIKA TROUGH

For the third consecutive year there were no exploration projects conducted in the Gataga sedex-lead-zinc-silver belt north of Williston Lake. The recently completed Mackenzie Land and Resource

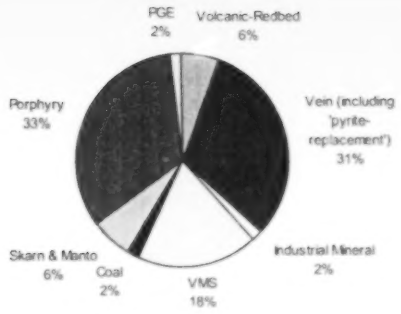


Figure 4. Exploration targets expressed as a percentage of total 2000 expenditures (estimated $6.2 million) in Northeast-Central British Columbia.

Management Plan (LRMP) may provide more certainty for the region in the future.

TOODOGGONE CAMP

Exploration activity in the Toodoggone region, east of Spatzizi Plateau was, for the most part, relatively low. Gold-bearing veins and gold-copper porphyry systems were the primary targets. A number of limited-budget projects focused on the porphyry potential between the Baker and Kemess mine sites.

Stealth Mining Corporation completed limited prospecting on the Goat and Wrich epithermal vein prospects, parts of its large **Pine** porphyry gold-copper property centered south of the Finlay River. Finlay Minerals Ltd. conducted seven line-kilometres of IP and magnetometer survey, as well as mapping and geochemical sampling, over its **Atty** porphyry copper-gold prospect. The Pine and Atty properties have a similar setting to that of the nearby Kemess South deposit.

OMINECA MOUNTAINS

A small number of exploration programs were conducted in the Omineca Mountains region, a broad area centered roughly between Takla and Williston lakes. Several diamond drilling programs were completed, including those at the Sustut, Carruthers, Lorraine-Jajay and Lustdust prospects. Investigative reconnaissance work by several companies in and around the Hogem batholith may lead to more advanced exploration in 2001.

The Southeast zone of the **Sustut** volcanic redbed copper deposit, located about 45 kilometres south of the Kemess mine, was the target of an infill diamond drilling program by owner/operator Doublestar Resources Ltd. The Southeast, Southwest and North zones, drilled by previous owner Falconbridge Ltd. in the early 1970s, comprise the property's indicated mineral resource of 21 million tonnes grading 1.11% Cu. Doublestar's 'upgraded' cumulative resource estimate for the Southeast zone, a potential starter pit, is 5.414 million tonnes grading 2.10% Cu and 6.8 g/t Ag at a cutoff grade of 0.90% Cu. Host rocks are dominantly green volcanic conglomerates, grits and sandstones of the Upper Triassic Moosevale Formation of the Takla Group. Permeability of these rocks played a significant role in formation of the stratabound zones. Mineralization consists mainly of disseminated chalcocite, bornite, chalcopyrite and native copper within tabular zones that are parallel to bedding.

Doublestar is moving ahead with a pre-feasibility study that is expected to be completed in the spring of 2001. The company is also investigating the merits of shipping ore directly to the Kemess mine for blending and processing. Exploration in 2001 is expected to focus on the North zone, where in-fill diamond drilling will take place to provide data for a new resource estimate. Although at an early stage, Doublestar is reviewing development options.

Phelps Dodge completed a 7-hole, 1000-metre diamond drill program on its **Carruthers** volcanogenic massive sulphide property near Johanson Lake in north-central British Columbia. The property is underlain by graphitic mudstones, siltstones and fine-grained sandstones of the Triassic Dewar Formation (Takla Group). Drilling intersected the projection of a narrow polymetallic horizon that is exposed in cliffs near the ridge crest. The mineralized horizon contains thin layers of pyrite and chalcopyrite up to 2 centimetres thick and millimetre-scale chalcopyrite veinlets.

Late in the year, after negotiating an option agreement for the **Lorraine-Jajay** property with Lysander Minerals Corp., Eastfield Resources Ltd. completed a brief exploration program focusing on two zones, the MacKenzie porphyry copper-gold zone discovered in 1999, and the BM Breccia copper-gold-platinum-palladium occurrence. The Lorraine-Jajay property is located approximately 190 kilometres northwest of Fort St. James and covers

Table 3. Major Exploration Projects, Northeast-Central Region, British Columbia - 2000.

Property (Owner)	MINFILE	NTS	Commodity	Deposit Type	Work Done
MINE SITES					
Gibraltar (Taseko Mines)	093B 012	93B/9W	Cu, Mo	porphyry	237 line-km grid; IP
Kemess (Northgate Exploration)	094E 021	94E/2	Au, Cu	porphyry	16 ddh, 5119 m; geophy prospect; geochem
Mount Polley (Imperial Metals)	093A 008	93A/12E	Au, Cu	porphyry	26 ddh, 4275 m; 156 pdh, 6404 m; geol
ADVANCED and EARLY STAGE PROJECTS					
Bonanza Ledge (International Wayside Gold Mines)	093H 019	93H/4E	Au	replacement(?), mesothermal vein	48 ddh, 6230 m; trench; 43 line-km grid; geochei geol; 18.5 line-km IP
Carruthers (Phelps Dodge)	094D 172	94D/8E	Cu, Zn, Au	VMS	7 ddh, 1000 m; geophys
Domin (Gold City Industries)	093H 133	93H/6	Au, Ag	mesothermal vein	17 ddh, 1000 m
Mosquito Creek Gold (Island Mountain Gold Mines)	093H 010	93H/4E	Au	pyrite replacement	10 ddh, 1754 m; re-establish grid, 25 line
Lottie Lake (Hudson Bay Exploration and Development)	-	93H/4, 5	Cu, Au	VMS	6 ddh, 709 m; prosp; ge 81 line-km grid; geophy geochem; trench
Lustdust (Alpha Gold)	093N 009	93N/11W	Au, Ag, Zn, Cu, Pb	skarn, manto	29 ddh, 4680 m
Spanish Mountain (Imperial Metals)	093A 043	93A/11W	Au	vein	1,908 tonne bulk sample
Stanley (Castle Metals)	093H 001-003, 082-083, 099-100	93H/4W	Au	mesothermal vein	geol; geochem; geophys trenching
Sustut (Doublestar Exploration)	094D 063	94D/10E	Cu, Ag	volcanic redbed	22 ddh, 2105 metres; geochem; geol

about 240 square kilometres, mostly underlain by alkalic intrusive rocks of the Hogem Batholith.

Five reconnaissance drill holes tested the MacKenzie porphyry copper-gold zone and intersected intrusive rocks that are intensely potassium-altered and host narrow zones of copper mineralization. Sampling across two nearby massive sulphide zones produced very encouraging results, including a 1.1 metre sample grading 19.27% Cu and 6.76 g/t Au. Selected grab samples of bornite-rich, clast-supported syenite breccia from the BM Breccia zone grade up to 38% Cu, 18.9 g/t Au, 3.4 g/t Pd and 0.66 g/t Pt.

Lustdust is an exciting carbonate-replacement (skarn and manto) prospect located 210 kilometres north-northwest of Prince George. Owner/operator Alpha Gold Corp. completed more than 4500 metres of diamond drilling in 29 holes in 2000. Most of the drill holes targeted prospective skarn zones, although the company did test areas further west for potential porphyry mineralization. The property lies west of the Pinchi fault and is underlain by folded, steeply west-dipping and northwest trending limestone, argillite and lesser mafic tuff of the Permian Cache Creek Group.

Photo 2. Diamond drill (foreground) testing the Southeast zone on the Sustut copper deposit.

The stratified rocks are intruded by a monzonite stock that is exposed on the western margins of the property and cut by a swarm of related(?) feldspar megacrystic dykes and/or sills. Mineralization is spatially and almost certainly genetically related to the intrusions. It strengthens at depth and toward the west, where several holes confirmed the presence of porphyry-style mineralization. Recognition of porphyry mineralization adds significantly to the potential of the property. Encouraging assays, mainly from skarn mineralization, include:

7.1 metres averaging 8.7 g/t Au in hole LD-20-09;

14.33 metres averaging 2.8 g/t Au, 34.3 g/t Ag, 0.7% Zn and 2.2% Cu in hole LD-20-13;

7.7 metres grading 4.4 g/t Au, 41.5 g/t Ag, 1.2% Zn and 2.5% Cu in hole LD-20-17, and;

4.12 metres averaging 1.8 g/t Au, 354 g/t Ag, 17% Zn and 0.9% Cu in hole LD-20-20.

North of Canyon Creek in a relatively little-explored area, a road side trench, TR-05, exposes a 2-metre wide zone of garnet-rich skarn alongside a QFP dyke that is mineralized with coarse-grained chalcopyrite and bornite. Disseminated and fracture-controlled chalcopyrite and pyrite extend laterally well into the dyke and hornfelsed argillite host. Sampling by the company across the 2-metre zone averaged 5.7 g/t Au, 351 g/t Ag, 12% Cu and 0.3% Zn within a 7-metre interval that averaged 5.1% Cu. This area is prospective for larger, more proximal skarns as well as gold-enriched porphyry copper mineralization. The company expects to build on these results and will likely proceed with an expanded exploration program in 2001.

ROCKY MOUNTAIN FOOTHILLS / NORTHEAST COAL BLOCK

There was little coal exploration in the northeast coal block in 2000. On the **West Brazion** coal property located 35 kilometres south of Hasler, Western Canadian Coal Corp. (WCC) completed limited field examinations and drilled one small-diameter, 90-metre core hole. Previous work had identified the Gething Formation coal measures in a flat-lying structure, and the hole intersected four seams totaling 8 metres in thickness over a 48-metre interval. WCC also investigated coal measures in the Gates Formation in the **Wolverine North** area (includes three of the Mount Spieker deposits). This property is 23 kilometres west of Tumbler Ridge. From compilation of earlier work and field studies the com-

pany identified two main targets, the underground Perry Creek deposit and the surface EB Pit deposit. The company also conducted limited surveying and trenching on its **Burnt River** property.

Interest in the coal bed methane potential of the province continues to grow and eyes are turning to the northeast coal block. This interest is expected to lead to a more robust level of activity in the near future.

NECHAKO PLATEAU

The Nechako Plateau area was quiet.

CARIBOO

Exploration activity in the Cariboo was energized early in 2000 with the discovery of the **Bonanza Ledge** high-grade gold zone near Wells, by International Wayside Gold Mines Ltd.. During the ensuing staking rush approximately 7900 new mineral claim units were recorded. Numerous option agreements were signed as many junior mining companies hustled to acquire tenure on the most prospective ground.

Most of the new staking covered areas considered promising for gold mineralization along the historic Wells-Barkerville belt. The belt is a 30 kilometre long, northwest-trending zone of lode gold mineralization and placers that has produced 38 million grams of lode gold and approximately 75 million grams of placer gold. It is underlain by deformed metasedimentary rocks of the Paleozoic Snowshoe Group, part of the Barkerville subterrane. Two styles of gold-bearing pyrite mineralization are known in the camp: (1) pyrite associated with quartz veins, such as those mined at the former Cariboo Gold Quartz mine immediately south of Wells, and (2) massive pyrite 'replacement' lenses within carbonate rocks, material that typified ore mined at the former Mosquito Creek Gold mine north of Wells.

International Wayside made the Bonanza Ledge discovery while drilling the BC vein, - a significant northwest-trending, steeply northeast-dipping quartz-pyrite vein located approximately three kilometres southeast of Wells. The first hole to penetrate the new zone was BC-2K-8. It encountered 5.7 metres of semi-massive pyrite that averaged 14.36 g/t Au in the immediate footwall of the vein. Recognition of this high grade material resulted in deeper step-out holes that targeted this new footwall zone, later named Bonanza Ledge. Holes 10 through 13 intersected some tremendously impressive intervals of gold mineralization (i.e. 25.8 metres averaging 24.65 g/t Au in hole BC 2K-10; 17.6 metres grading 20.795 g/t Au in hole BC 2K-12; and 33.2 metres grading 10.60 g/t Au in hole BC 2K-13) that confirmed the high grade nature of the discovery.

Mineralization is hosted by an isoclinally folded and overturned package of phyllitic argillites, silty dolostones and metaturbidites of the Hardscrabble Mountain succession near its contact with the structurally overlying Downey succession (Rhys and Ross, 2000). The Bonanza Ledge auriferous pyrite mineralization occurs as stringers, concordant layers and massive bands (10 - 70% pyrite) within a 20 to 100 metre wide envelope of pronounced iron/magnesium carbonate-sericite-pyrite alteration that discolours the host rocks to shades of tan and yellow (Photo 3). The wider intersections of mineralization may be associated with thickening of the zone in, or near, fold hinges of the tightly folded host rocks. The zone has been traced northwesterly along strike for more than 130 metres. Mineralized zones may be elongate and plunge gently northwest, similar in geometry to the pyrite replacement lenses at the former Mosquito Creek Gold mine. The hangingwall rock package includes a distinctive, medium to pale green chloritic phyllite (metatuff?) that typically contains 2% to 5% disseminated magnetite porphyroblasts (Photo 4). This unit provides an excellent stratigraphic marker for the belt.

By the end of the year 2000 field program, International Wayside had drilled 48 holes in the Bonanza Ledge area. Geological mapping, soil geochemistry and an Induced Polarization survey were also completed in the area, as well as along the projected strike of the zone.

Several new targets were identified for further detailed examination during 2001, including a 1.2 kilometre long gold in soil anomaly located two to three kilometres northwest of Bonanza Ledge.

Golden Cariboo Resources Ltd. examined its **Grouse Creek** property, which lies southeast and along trend from the Bonanza Ledge zone. Prospecting identified locally altered (bleached) magnetite-bearing intermediate volcanic rocks and grey phyllitic argillites in a stratigraphic position consistent with the overturned Hardscrabble Mountain succession. A more advanced level of exploration, including diamond drilling, is planned for 2001.

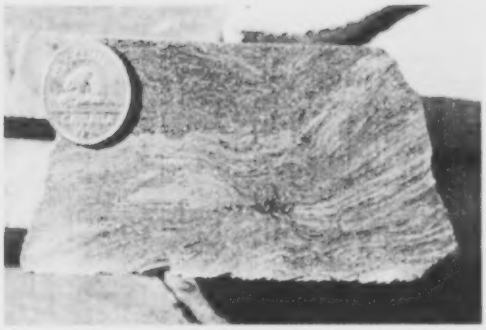


Photo 3. Close-up of auriferous pyrite mineralization from hole BC 2K-19, Bonanza Ledge zone.

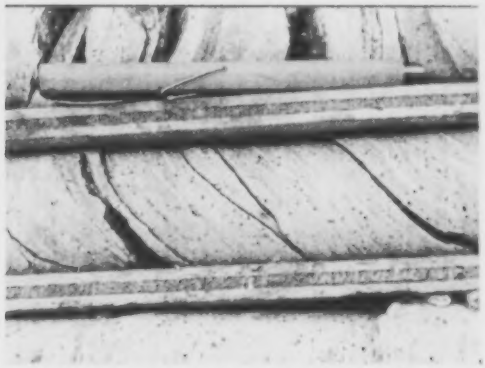


Photo 4. Close-up of hangingwall rocks with distinctive magnetite porphyroblasts (hole BC-2K-15), Bonanza Ledge zone.

At the former **Mosquito Creek Gold** mine, Island Mountain Gold Mines Ltd. conducted a 10-hole, 1754-metre diamond drilling program aimed at stratabound auriferous "pyrite-replacement" mineralization in the Main Band limestone unit of the Baker member (Downey succession). The drilling, centred just northwest of the mine's headframe, intersected several narrow mineralized zones, including a 0.6 metre interval in hole IMG-2K-03 that graded 15.07 g/t Au. The program also included line-cutting and soil sampling.

Gold City Industries Ltd. conducted grid-based mapping, sampling and SP and IP surveys over parts of its **Myrtle** property. The southwest edge of the Myrtle claim group shares a common boundary with International Wayside's claims near the Bonanza Ledge discovery. Two chargeability anomalies were outlined, one of which is coincident with a large multi-element soil geochemical anomaly, and both are high priority targets for a 2001 diamond drilling program. Gold City also conducted preliminary examinations on its nearby **Proserpine** and **Promise** properties.

Joint venture partners Castle Metals Corp. and Gold Giant Minerals Inc. completed prospecting, geochemical sampling, magnetometer-VLF surveys on 4 small grids, and trenching on their **Stanley** project (Grub claim group). The property is near Lightning Creek, south of the historic townsite of Stanley. It encompasses a number of former placer diggings, including several significant hydraulic pits, and several bedrock showings.

Nevsun Resources Ltd. made a brief visit to its **Warspite** property, five kilometres southeast of the former Cariboo Gold Quartz mine, and may explore this very prospective ground in earnest during 2001.

Tenure covering the former **Cariboo Hudson** gold mine, located toward the southeast end of the Wells-Barkerville belt, was allowed to lapse in the late winter, 2000. It was quickly restaked by the previous owner, Cathedral Gold Corporation, after news of the Bonanza Ledge gold discovery came to light. In the fall, the company relogged core from several mid-1980s drill holes to look for indicators of the camp's pyrite replacement-style of mineralization. The core consists of a series of pale green phyllitic layers with lesser black phyllite, quartzite and grey marble beds.

Hudson Bay Exploration and Development Company Limited completed a five-month multidisciplinary program on its **Lottie Lake** volcanogenic massive sulphide project located 20 kilometres north of Wells. The property incorporates the Lottie, Bow and Tow float anomalies and is underlain primarily by basic to intermediate volcanic rock, argillaceous sediment and chert of the Antler assemblage (Slide Mountain Terrane). Work in year 2000 consisted of prospecting, geological mapping, geochemical sampling, ground electromagnetics (EM), and Spectrum airborne EM surveys, trenching and diamond drilling. The program confirmed that high grade float occurs on the property and identified several EM conductors, one of which is close to the Lottie float anomaly. Diamond drilling and trenching did not locate the bedrock source of the float. Exploration is expected to continue in 2001.

Further north, Gold City undertook a prospecting, geochemical sampling and diamond drilling program on its **Domin** high-grade gold-silver vein prospect. The property, optioned from vendors Ron Mac-

Arthur and Al Raven, is located north of Bowron Lake Park, 43 kilometres northeast of Wells. The property is underlain mainly by complexly folded calcareous argillites and limestones of the Hadrynian Isaac Lake Formation. Mesothermal quartz±sulphide veins that comprise the South zone are exposed over a 50 by 150 metre area, immediately west of the Isaac Lake fault. Veins are up to 4.4 metres thick. The 'A' veins occur in structures parallel (~155°) to the Isaac Lake fault and 'B' veins are localized along planes parallel to bedding. A 17-hole diamond drilling program that tested a 200 metre strike length of the South zone, produced encouraging results. One 1.8 metre intersection in hole 00-GDD-05 graded 10.33 g/t Au, 66.9 g/t Ag, 2.6% Pb and 6.7% Zn. At the North zone two new high grade gold veins, one with 23.84 g/t Au over 0.6 metre and the other with 68.66 g/t Au over 0.2 metre, were discovered within a 400 by 500 metre multi-element soil geochemical anomaly. A more aggressive exploration program is expected in 2001.

LIKELY AND HORSEFLY AREAS

New mineral claims were also staked north and northwest of Likely to cover ground with platinum group element (PGE) potential. Barker Minerals Ltd. was one of the most aggressive companies, acquiring a large amount of mineral tenure mainly north and west of Likely. Big Valley Resources Ltd., Richfield Resources Ltd. and Noble Metal Group Incorporated are also major tenure holders in this prospective area. Most exploration efforts included compilation of all existing data, detailed prospecting and geochemical sampling, especially in areas that coincide with magnetic anomalies. Claims west of the Eureka fault are underlain by Middle to Late Triassic basin fill (the 'black clastic' unit) and the overlying Late Triassic to Early Jurassic volcanic arc assemblage of the Quesnel River Group. The occurrence of PGEs in this area may be associated with Early Jurassic copper and gold-bearing alkalic intrusions or perhaps with gabbroid intrusions. Claims east of the fault are underlain by metamorphosed volcanic and sedimentary rocks of the Paleozoic Snowshoe Group. These rocks are locally cut by ultramafic intrusions that are a possible source of the platinum that was recovered from a number of historic placer operations. East of Likely, Noble Metal Group drilled two deep core holes to evaluate an ultramafic body on its mineral claims that straddle Keithley and Snowshoe creeks. Results are not yet available.

Imperial Metals examined five zones on the **Spanish Mountain** gold property, located east of Likely, which it optioned from Wildrose Resources Ltd.. The Dodge Pit, 103, LE, M5 and Madre zones were stripped and percussion drilled on two to five metre centers. A 1908 tonne bulk sample was mined from the LE zone and trucked to the Mount Polley mill for processing. Gold-bearing mineralization consists mainly of variably oxidized pyrite and quartz-pyrite stringers in graphitic argillite and siltstone. The sediments are part of the Middle to Late Triassic succession that forms the base of the Quesnel Group. The average head grade of the material mined was 3.02 g/t Au. Results are reported to be encouraging and additional metallurgical work and exploration may proceed in 2001.

Immediately north of the Mount Polley mine Big Valley Resources Inc. diamond drilled the **Lloyd 2** porphyry copper-gold prospect late in the year. Three of the four holes drilled intersected pyrite and sericite-altered intrusive rocks of the Polley stock. Assays from the core have not yet been released.

At the **Ace** and **Frank Creek** volcanogenic massive sulphide projects east of Likely, Barker Minerals Ltd. continued to evaluate its vast tenure package. Further prospecting resulted in discovery of the **SCR** showing, approximately eight kilometres west of Frank Creek. The company interprets stringer-type mineralization hosted by felsic volcanic rocks of the Barkerville subterrane and semi-massive to massive sulphide mineralization in float to be from a previously unrecognized volcanogenic massive sulphide system. The company completed 140 line-kilometres of line cutting and HLEM and magnetic surveys over the Ace, Frank Creek and SCR target areas. The company intends to drill several of the targets early in the 2001 field season.

Erin Ventures Inc. optioned the **Stope Baby** property, which is located five kilometres southwest of Horsefly, from prospectors Jack Brown-John and Herb Wahl. A series of narrow, sub-vertical, north-trending quartz-carbonate-sulphide veins are exposed at low water over about a 70-metre width in Moffat Creek canyon. The veins occur in Jurassic (Pliensbachian?) maroon amygdaloidal and vesicular olivine pyroxene basalts. The veins contain comb quartz and coarse bladed sphalerite, classic epithermal vein textures that indicate open space filling. Segments of veins comprise 15 to 25% coarse-grained sphalerite and lesser chalcopyrite, galena and pyrite (Photo 5). The vein system was the target of prospecting, an IP survey, and a two-hole, 348-metre diamond drilling program. Core assays are not yet available, but a selected grab sample from 'Vein

Photo 5. Sphalerite and chalcopyrite-bearing (dark clusters) epithermal quartz-carbonate vein, Stope Baby property.

1" assayed 10.73% Zn, 0.88% Cu, 92.6 g/t Ag and 0.614 g/t Au. The veins could be related to an unrecognized porphyry system located further south.

The **Keno** (Bren 093A 079) porphyry molybdenum-copper prospect, located 32 kilometres east of Horsefly, was drilled by property co-owners Jack Brown-John and Herb Wahl. Previously the area was explored as a gold vein prospect. However, its potential as a porphyry system was realized in 2000 during the 4-hole, 603.5-metre drill program. Early Jurassic dykes and stocks of altered monzonite intruded and metamorphosed argillites of the late Triassic Quesnel Group. Fracture-controlled molybdenite occurs consistently throughout the full length of hole K00-03, but is most conspicuous in zones of moderate to intense argillic alteration. Ribboned quartz-molybdenum veins that are up to 10 cm across cut the altered intrusion. Traces of chalcopyrite are present, but uncommon. The most encouraging intersection was from hole K00-03 where an 87 metre interval averaged 324 ppm Mo.

PRELIMINARY REPORT ON PLACER ACTIVITY

By Ken MacDonald, P.Geo.
Mines Branch, Prince George

The placer sector in northeast-central British Columbia experienced a general decline from the already depressed levels of activity encountered over the past several years. Accurate estimates of expenditures on exploration and testing are unavailable but are expected to be down from 1999. There were fewer major projects this year as most operators were more inclined to conduct modest testing programs for assessment purposes. Overall, the amount of new ground explored and material (paydirt) processed decreased. High fuel costs and low commodity prices contributed significantly to the general decline.

The continued downward turn in placer mining activity is reflected in the relatively low number of Notices of Work (NoW) applications submitted to the Prince George office. A total of 422 placer NoWs were filed, compared to 393 in 1999 and 403 in 1998. Of the total, 209 NoWs were for mechanical testing and 213 comprised hand work. To date only 125 or roughly 40% of the operators have responded with a Notice of Completion (NoC), therefore this summary is preliminary.

Based on NoCs received to date, the work completed either was generally less than the applicant had originally planned or was cancelled. In terms of testing and size, the complete breakdown is as follows: 20 programs were inactive, 17 were hand operations, 3 did limited testing, 36 washed greater than 10m³ of material, 30 washed greater than 100m³, 19 exceeded 1000m³ of washed gravel. In terms of significant placer production, only two programs processed in excess of 5000m³ of paydirt. No information is available on the quantity of gold recovered or grade of material washed.

As in past years, the focus of activity followed a well established pattern. The Cariboo was the principal center of activity followed by the Omineca and Hixon areas. Twenty-six programs employed three or more workers, while the majority of programs (99) saw only one or two workers onsite, typically the owner of the tenure and spouse or partner.

Two of the three largest programs, for which reliable information has been obtained, were located in the Germansen Landing-Manson Creek placer camp. J. Hirak and G. Hobson continued to produce from an existing main mine area on the Manson River, and reported 5000m³ of paydirt washed. Meanwhile J. Thomas of Angel Jade Mines completed bulk testing from three pits near Slate Creek, for a total of about 4400m³ of paydirt washed. Encouraging results may lead to a large-scale operation in 2001.

Elsewhere on the Manson River, R. Gauthier completed a modest program of about 1200m³ of production from a single pit. Angel Jade completed several separate programs on different holdings in

Photo 6. Small-scale testing operation conducted by R. Dubie on Goodasany Creek, Omineca region (photograph by David Pow, Inspector of Mines, Prince George).

the camp, including 1150m³ of paydirt developed from 11 test pits on one property, and 420m³ of paydirt from 17 smaller test pits on a nearby property. Both programs sought to identify and confirm continuity of prospective gravel horizons. P. Ewaskow tested 600m³ of paydirt from several pits on his tenure.

Several other noteworthy exploration programs were conducted on properties located peripheral to the main Germansen Landing-Manson Creek camp. V. Pogoreve tested about 1000m³ of gravel on McConnell Creek over a period of 15 weeks. B. Watson washed roughly 1250m³ on his tenure on Twenty Mile Creek and B. Frappier washed about 300m³ of paydirt over a period of 24 weeks on Lost Creek. On Goodasany Creek, R. Dubie washed 700m³ of paydirt extracted from one main mining area and 5 test pits (Photo 6).

The largest program conducted in the Wells-Barkerville region was located on Barry Creek, a small tributary of the Willow River. D. Romonow mined roughly 5000m³ of material from a steep embankment that had previously seen only limited testing. Results were disappointing and the remainder of the planned two year program has been cancelled. B. Scobey and family remained onsite at their Beaver Pass creek site for 10 weeks and processed about 2300m³ of paydirt.

G. Jennex continued limited production, about 2000m³ of paydirt, from an area on Burns Creek where the famous Hatton Nugget was found. Limited testing by the Kleman brothers on Cunningham Creek during the season included about 2000m³ of gravel processed from one main pit, and 3 km of significant road rehabilitation. The Klemans also processed about 300m³ of material on Montgomery Creek in 4 test pits.

Monitor International Corp. continued development of several leases on the Quesnel River, albeit at a much reduced production level. Only about 800m³ of material was processed by a team of three workers over a 4 week period. K. Thompson processed 450m³ of gravel from a claim on the lower Cottonwood River.

A. Bruce mined about 700m³ from 5 test pits on

the Cariboo River. Another operator on the Cariboo River, J. Naychuk, processed about 1600m³ of paydirt from two trenches dug into old dredge workings on an elevated river terrace. Meanwhile, D. Boyes completed 3700m³ of production from 4 large bulk sample pits on the Quesnel River near Buxton Creek.

On upper Cunningham Creek, C. Winther completed 2500m³ of production from several satellite pits. Noble Metals was unable to complete plans for a major stripping program, and settled for limited production of about 500m³ of paydirt from 4 test pits on their large lease holdings on Keithley Creek.

The number of active placer operations during 2000 remained at about the same level as in 1999. However, following a trend that has developed over the past several seasons, the average size of the operation and total exploration expenditures decreased, mainly in response to depressed gold prices and rising fuel costs. Exploration during 2001 will continue to focus on traditional streams and creeks in the Wells-Barkerville, Likely, Hixon and Germansen River-Manson Creek camps.

OTHER INFORMATION

The Prospectors Assistance program awarded grants totalling $53,887 to support seven grassroots exploration projects in the region. The projects targeted a range of commodities including industrial minerals, copper, gold and PGEs.

During the 2000 field season, the British Columbia Geological Survey Branch conducted four programs in the Cariboo region and one in the northern Omineca region. In the Cariboo, Peter Bobrowsky carried out detailed overburden mapping and sampling over a broad area underlain by Slide Mountain terrane rocks north of Wells and a small area southeast of Likely; Fil Ferri mapped the Late Proterozoic to Paleozoic Snowshoe Group south of Cariboo Lake; Gerry Ray and Ian Webster completed a detailed examination of styles of mineralization in the Wells-Barkerville belt, and; Chris Ash conducted detailed structural and geological mapping of accessible areas of the Gibraltar mine. In the Omineca Mountains, Andrew Legun completed a regional bedrock mapping program over an area that included the Sustut copper deposit. Results from these programs are published in the annual Geological Survey Branch 'Fieldwork' volume (Geological Fieldwork 2000, Paper 2001-1) and/or as 'Open File' maps or reports.

OUTLOOK

Exploration activity is expected to continue to increase during 2001, with more projects and higher total expenditures. Exploration and investment incentives that are now available are expected to encourage significant renewed interest in the mineral wealth of the region.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the many contributions provided by mine staff, exploration geologists and prospectors working throughout the region. Without their generosity, the compilation of this report would not be possible. Ken MacDonald, Inspector of Mines (Mines Branch, Prince George), provided the update on placer activity in the region; he, Robert Pinsent, Research Geologist (Geological Survey Branch, Vancouver) and external editor, Bill McMillan, provided useful editorial comments that improved the manuscript.

REFERENCES

Rhys, D.A. and Ross, K.V. (2000): Report on Petrography, Check Sampling and Geological Interpretation of Drill Core at the Bonanza Ledge Zone, Cariboo Gold Quartz Property, British Columbia; Unpublished Report for International Wayside Gold Mines Ltd., 70 pages.

SOUTHWEST REGION

By Jacques Houle, P. Eng.
Regional Geologist, Nanaimo

INTRODUCTION

The Nanaimo Regional Office of the Mines Branch of the Ministry of Energy and Mines is a small, client-focused group which advocates, monitors, and enforces provincial legislation for, all exploration and mining activities in the Southwest Region. These include mineral, placer, coal, industrial mineral, and sand and gravel projects. Since April, 2000 a Regional Geologist position has been based in Nanaimo. The district was formerly covered from the Vancouver office by Robert Pinsent, P.Geo., who remains with the Geological Survey Branch as a Research Geologist with the Vancouver Mineral Development Office.

HIGHLIGHTS

- Boliden-Westmin (Canada) Ltd. achieved planned production levels of Cu-Zn-Au-Ag ore at its Myra Falls Operation near Campbell River and positive exploration results on several mine-site area targets. The precious metal-rich Becherer Zone, was delineated and mined in part by open pit methods at the site of the former Lynx Mine. This deposit contributed significantly to maintaining the modest profitability of the mine. Boliden also announced its intent to seek a funding partner for the Myra Falls Operation as part of its corporate strategy to focus primarily on its Scandinavian operations. Several potential partners visited Myra Falls during the latter part of the year.

- Tilbury Cement Ltd. completed a successful drilling program to define the potential of deposits of chalky geyserite (silica) at its Pem 100 Project near Port Hardy. Bulk sampling is planned. The geological resource is estimated at 5 million tonnes at grades of 80-85% Si_2O_3 and 2-20% Al_2O_3.

- Graymont Western Canada Inc. also completed a promising drill program to delineate a limestone deposit at its Nimpkish Project near Port McNeil.

- The Hope - Harrison Lake area saw 750 claim units staked and preliminary prospecting activity targeting gabbroid associated Ni-Cu-PGE's in the highly metamorphosed nickel belt northwest of the past producing Giant Mascot Mine of Homestake Canada Inc. Stakeholders include Santoy Resources Ltd., partners John Chapman and Gerry Carlson, David Deering and associates, and Prospector's Assistance Program grantees David Haughton and Murray McClaren.

- In late 2000 and early 2001, several junior companies sold flow-through share issues to fund noteworthy exploration programs primarily to evaluate the potential and grades of previously discovered gold quartz veins on Vancouver Island. These include SYMC Resources Ltd.'s Mctush Project near Port Alberni, Beau Pre Explorations Ltd.'s Valentine Mountain Project near Victoria, and pending work by Newmex Minerals Inc. at their Privateer Mine Project near Zeballos.

EXPLORATION AND PRODUCTION TRENDS

Unlike the positive upturn seen elsewhere in the province, exploration activity continued to decrease in the Southwest Region during 2000. Only three exploration projects had expenditures exceeding $100,000 (Table 1), with an additional six projects having expenditures between $50,000 and $100,000 (Table 2). Estimated total expenditures for the district are only $3.5 million; both major projects and

Table 1. Southwest Region, 2000, Major Exploration Projects (> $100,000).

Project & Owner	MINFILE & NTS	Commodities & Deposit Type	Work Items & Amounts
Pem 100	092L 063,150,269	Chalky Geyserite	dd - 24 h
Tilbury	092L 12E	Epi/hydrothermal	- 627 m
Nimpkish	092I 186	Limestone	dd - 22 h.
Graymont	092I 07W	Sedimentary	- 2,464 m
Myra Falls	092F 071,073,330	Cu,Zn,Au,Ag	dd-u/g-15km
Boliden	092F 12E	Volc. Mass. Sulf..	-surface-2km.

Table 2. Southwest Region, 2000 - Significant Exploration Projects ($50,000 - $100,000).

Project & Owner	MINFILE & NTS	Commodities & Deposit Type	Work Items & Amounts
Privateer Newmex	092L 008 092L 02E	Au, Ag Au Quartz Veins	staking, u/g bulk sampling
Raven Cream	New Discovery 092E 10W	Cu,Zn,Au,Ag Volc. Mass. Sulf	staking, airborne geophysics
Yew 555 Corp.	092F 364,516 092F 10E	Au,Ag,Cu Cu Skarn	bulk sampling test milling
Mctush SYMC	092F 012,168 092F 02W	Cu,Mo,Au,Ag Porphyry, Veins	trenching, dd 6 h; 350 m
Valentine Beau Pre	092B 108,075 092B 12W	Au,Ag,Cu Au Quartz Veins	bulk sampling dd.8h.,182 m
Pt.Douglas Platinate	092GNE 041, etc. 092G 09,15,16	Cu,Zn,Au,Ag VMS & Veins	staking,geol., geochem

total spending are all-time annual lows for the region.

Mine-site exploration at Boliden-Westmin's Myra Falls operation accounted for more than half the exploration expenditures, and more than three quarters of the exploration drilling in the southwest in 2000. Figures 1, 2 and 3 show key exploration indicators for the region over the past ten years: annual major exploration projects, annual exploration expenditures and annual exploration drilling. Figure 5 shows the locations of major exploration projects, and the six projects with expenditures between $50,000 and $100,000. With the help of changes in flow-through funding regulations in late 2000, and the extended field season available on Vancouver Island, up to three of these projects could achieve major status in early 2001.

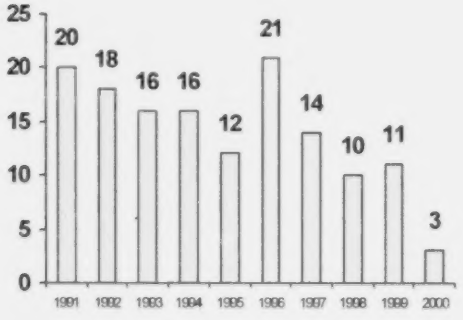


Figure 1. Number of Major Exploration Projects (>$100,000) Annually in the Southwest Region.

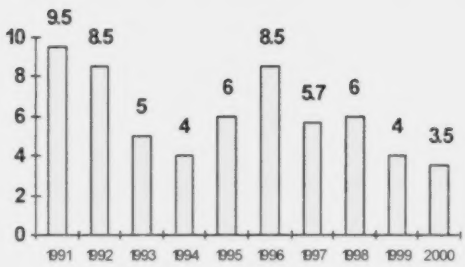


Figure 2. Annual Exploration Expenditures, Southwest Region (in C$ Millions).

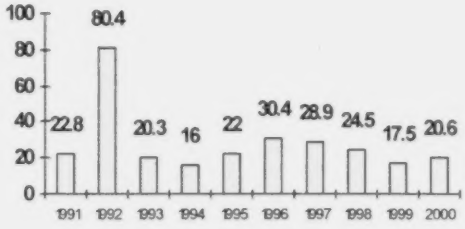


Figure 3. Annual Exploration Drilling, Southwest Region (in thousands of meters).

Both the tonnage and value of mineral production in the region increased in 2000, as stability was restored at most of the operations and commodity prices generally increased. One major metal mine, one coal mine and two major limestone quarries operated in the Southwest Region in 2000, as well as several smaller but noteworthy industrial mineral operations. Major mines and quarries in the region (Figure 4), prospector activity (Figure 6) and the exploration projects demonstrate both the diversity of mineral deposit types and the innovation of operators and explorationists working in the region.

PRODUCING MINES AND QUARRIES

In addition to the four major mines and quarries, there are many large sand and gravel operations and several small industrial mineral producers in the Southwest Region. Industrial minerals produced are limestone, silica, fireclay, pumice and dimension stone; some of the operations are new and may point to appreciable growth in the years ahead.

MYRA FALLS OPERATION

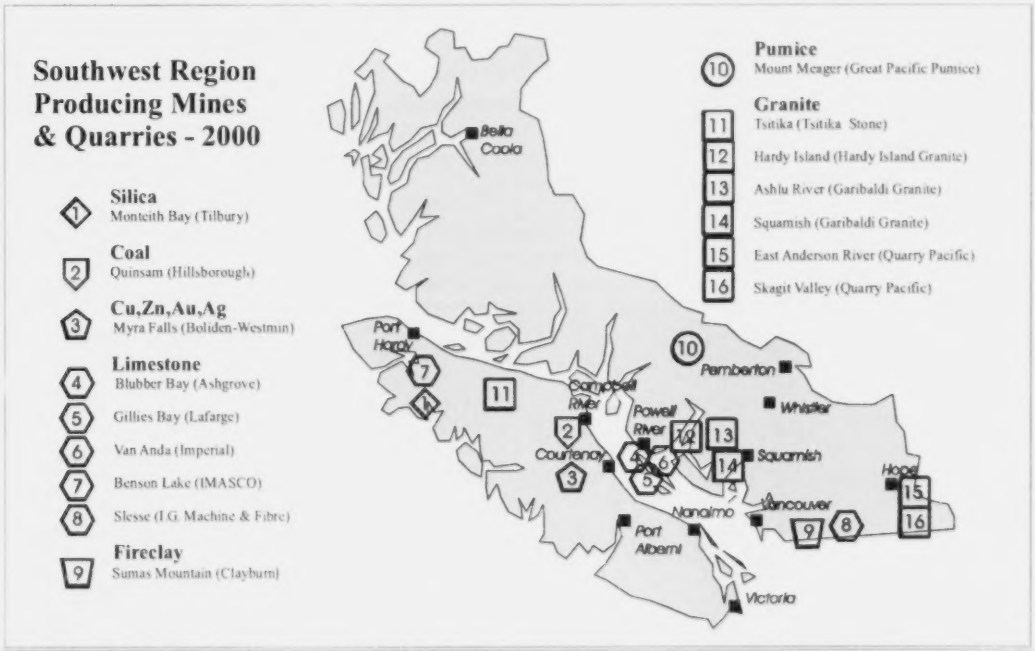
Boliden-Westmin (Canada) Ltd. mines a large, geologically complex, volcanogenic massive sulphide deposit in Paleozoic Sicker Group rocks at its Myra Falls Operation, near Campbell River. They employ about 440 people, and have a nominal mill capacity of 3850 tonnes per day.

As of January 1, 2000, Myra Falls had a mining reserve of 7,720,000 tonnes at 1.4% Cu, 7.3% Zn, 0.5% Pb, 1.4 g/t Au and 38.9 g/t Ag. This global reserve is derived from a number of clustered orebodies, including the Lynx, Battle-Gap, 43-Block, Extension, H-W, Myra, and Price deposits. They should provide about 7 years of mill-feed at the current production rate of about 3000 tonnes per day. The mine also had a geological resource of 5,550,000 tonnes at 1.4% Cu, 7.2% Zn, 0.7% Pb, 1.6 g/t Au and 56.5 g/t Ag. This resource reflects the higher precious metals grades of the smaller peripheral parts of the deposits and their extensions. If successful, highly focused exploration work conducted annually on the Myra Falls property will convert these resources into reserves.

In 2000, the Myra Falls Operation milled 1,171,031 tonnes grading 1.72% Cu, 5.04% Zn, 1.59g/t Au, and an estimated 25.3 g/t Ag at an average cash cost of US$0.40 per pound of zinc (quoting all payable metals as zinc equivalent). Underground ore sources consisted of the H-W, 43-Block and Battle-Gap deposits, with open pit ore coming from the Lynx deposit. In October, 2000 Boliden Ltd. announced that they would seek a funding partner to assist with future capital expenditure requirements at the Myra Falls Operations. This represents part of its corporate strategy, which is to focus on its Scandinavian assets, reduce costs, improve productivity and defer non-discretionary expenditures. Exploration staff and budgets at the Toronto office were significantly reduced, and exploration activities throughout North America, including regional work on Vancouver Island, curtailed.

Exploration during 2000 by Boliden-Westmin been focused entirely on gaining additional information on known resources at Myra Falls in order to upgrade their reserve/resource categories and to better assess their mining potential. Estimated year 2000 expenditures for minesite exploration were C$2 million, which funded 17,184 meters of drilling, mostly from underground. Deposits tested by underground drilling included the East and West Ridge Zones, which are located to the west of the Battle-Gap deposit, and the Extension Zone, which lies

Figure 4. Southwest Region Producing Mines and Quarries - 2000



west of the H-W deposit; as well, the Price Deposit was tested by surface drilling from Thelwood Valley. A particularly successful hole (LX10-2045) tested the Ridge Zone West from the Lynx 10 Level. It intersected 20.9 m. of 1.90% Cu, 2.03% Pb, 18.67% Zn, 2.5 g/t Au and 138.8 g/t Ag. This intercept is close to the true thickness of the zone, which is hosted by distal facies rocks of the H-W horizon that consist of silicified rhyolite ash/chert beds, coarse tuffs and lapilli tuffs.

In 2001, it is anticipated that exploration efforts will continue in the Ridge Zones with drilling from, and required development on, the Lynx 10 Level. Drilling will also be carried out from the Price 13 Level to test an area east of the H-W deposit, from the Price 4 Level to test the Price deposit, and from surface in the area between the former Lynx and Myra mines.

Production is expected from a new surface ramp that will be collared from the bottom of the Lynx pit to extract the down-plunge extension of the Becherer Zone. Other plans are to construct a paste backfill plant at Myra Falls, which would permit the use of mine tailings as ground support underground and also make surface tailings more manageable than liquid tailings presently produced.

QUINSAM COAL MINE

Hillsborough Resources Ltd. holds 100% interest in Quinsam Coal Corporation, owner/operator of a small underground coal mine near Campbell River, on Vancouver Island. During 2000, the companies were successful in restructuring their finances, and resumed commercial production in early October. Production during 2000 from the Quinsam Coal mine was 236 536 tonnes of clean, bituminous grade thermal coal from underground flat-lying seams in the Cretaceous Nanaimo Group. The seams are accessed by ramps. The mine operated on a single-shift basis in 2000, and shipped only to markets in the Pacific Northwest. Due to operational improvements and commodity price increases, the mine achieved profitability.

Hillsborough also holds a 75% interest in T'Sable River Coal Corporation, which has an undeveloped coal deposit south of Courtenay in similar rocks. Although plans to develop this deposit are currently on hold, interest has been increasing in the coal bed methane potential of both properties.

LIMESTONE QUARRIES

Texada Island hosts the two largest suppliers of limestone in the Pacific Northwest, and these are also the largest and third largest quarries in Canada, based on total annual production. Between them, the Blubber Bay Quarry of Ash Grove Cement Corporation, and the Gillies Bay Quarry, of Lafarge Canada Inc. (through Texada Quarrying Ltd.) are estimated to have produced 5 million tonnes in year 2000. Most is used in production of cement. In contrast, chemical grade limestone is produced both by the Van Anda Quarry, of Imperial Limestone Co. Ltd., and from some of the Gillies Bay Quarry output. All three operations produce from the thick massive, flat dipping Triassic Parsons Bay Formation limestone; it is up to 500 meters thick and covers much of northern Texada Island.

On Vancouver Island, International Marble and Stone Co. Ltd. continued to produce white, chemical grade limestone from its Benson Lake Quarry near Port Hardy. During the year, I.G. Machine and Fibre Ltd. completed test mining from its South Slesse Creek limestone quarry near Chilliwack, but no further mining is planned at this time.

DIMENSION STONE QUARRIES

Several of the dimension stone processors in the lower mainland and on Vancouver Island use local stone. Generally, stone is produced on a seasonal basis from small quarries that are worked when material is required. Varieties of granitic rock are the most common product. Stone-processing plants are operated by Westcoast Manufacturing Inc. in Delta, Margranite Industry Ltd. in Surrey, Garibaldi Granite Group Inc. in Squamish, and Matrix Marble Corporation in Duncan.

Margranite processes a variety of imported granite, but also local granite from two of its quarries that are located in the Southwest Region near Hope; one is at East Anderson River and one in the Skagit Valley. Garibaldi Granite processes local granite from its quarry sites at Squamish, and just to the north at Ashlu River. Garibaldi also produces some specialty products from columnar basalt and rhyolite sources.

Tsitika Stone Industries on northern Vancouver Island produces grey granite from its Tsitika Quarry, and Hardy Island Granite Quarries Ltd. produces granite from its quarry south of Powell River. Most of this material is processed in the lower mainland.

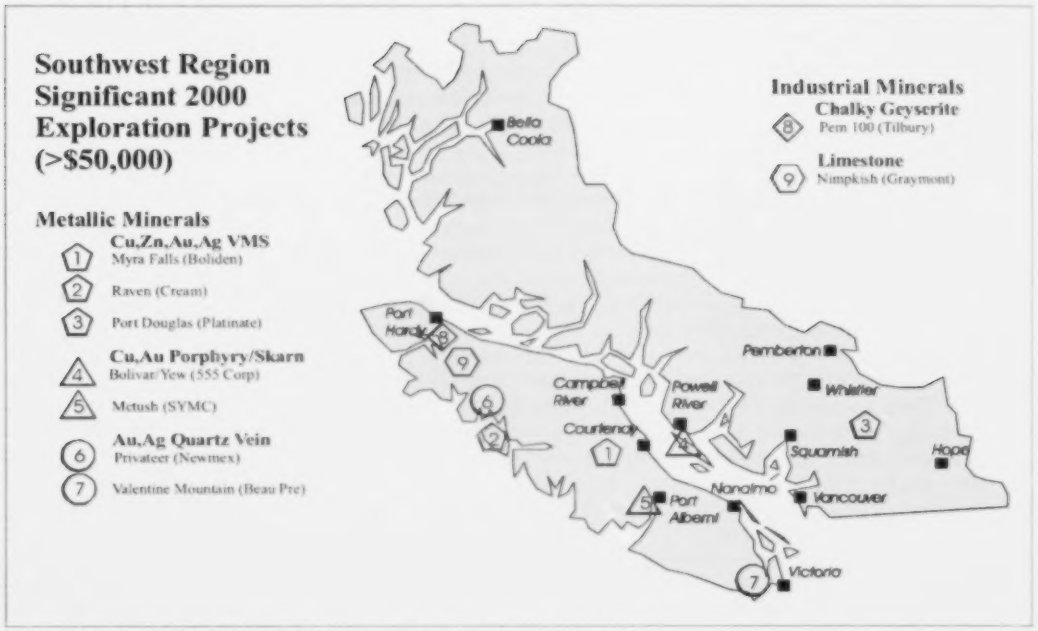


Figure 5. Southwest Region Significant 2000, Exploration Projects (>$50,000).

OTHER INDUSTRIAL MINERALS

The number and variety of industrial minerals produced in the region continues to increase as local populations and markets grow. Growth is also spurred when the potential of new products, like silica sinter, is recognized. Industrial minerals continue to have positive future development potential in the Southwest Region.

Monteith Bay Resources Ltd., an affiliate of Tilbury Cement Ltd., produced and shipped silica-rich 'chalky geyserite' from its Monteith Bay Quarry on western Vancouver Island to Tilbury's cement plant in Delta. Lafarge Canada Inc. uses limestone from Texada Island, coal from the Quinsam Mine and silica from Fraser River sands in its cement plant in Richmond.

Clayburn Industries Ltd. produces fireclay from its Sumas Mountain Quarry for its nearby plant in Abbotsford, which manufactures a variety of refractory bricks, flueline pipe and facing bricks. Great Pacific Pumice Ltd. is mining pumice from its Mount Meager property near Pemberton. Material produced is used in light weight, high strength concrete and for cosmetics.

EXPLORATION ACTIVITY

VANCOUVER AND INSHORE ISLANDS

PEM 100 (MINFILE 092L 063, -150, -269)

Tilbury Cement Ltd. and partner Homegold Resources Ltd. completed a 25 hole delineation diamond drilling program on the Pem 100 (formerly Apple Bay) chalky geyserite (silica) deposit located near Port Hardy. Bulk sampling of the deposit is planned for 2001.

NIMPKISH (MINFILE 092I 186)

Graymont Western Canada Inc. completed a 2,464 meter drilling program to evaluate a limestone deposit at its Nimpkish Project near Port McNeil.

PRIVATEER (MINFILE 092L 008)

Newmex Minerals Inc. continued underground test mining, bulk sampling, and test milling of gold-bearing quartz veins at its Privateer Mine near Zeballos. Newmex increased its property position in the Zeballos Camp by acquiring the mineral rights to several past producing gold-silver properties, includ-

ing the Mount Zeballos deposit (MINFILE 092L 012). The company also staked 40 mineral claim units to cover an area of favourable geology with potential for replacement type gold deposits. The claim block is immediately to the southwest of the Privateer Mine and covers the area between the Beano (MINFILE 092E 002) and Tagore (MINFILE 092L 006) deposits, both of which are past producers of replacement type ore. Newmex plan a $150,000 flow through-funded exploration program on the Privateer and adjacent properties for early 2001; it will consist of both underground and surface work.

RAVEN (NEW)

Geologists Michael Moore and Paul Metcalf, along with prospector Seamus Young, discovered and staked a new massive sulphide occurrence in Paleozoic age Sicker Group volcanics on Nootka Island off Vancouver Island's west coast. They subsequently optioned the property to Cream Minerals Ltd., who completed a Dighem airborne geophysical survey.

MCTUSH (092F 012, -168)

SYMC Resources Ltd. completed exploration trenching and rock sampling on several gold-bearing quartz vein targets that are spatially associated with porphyry Cu-Mo-Au mineralization in Jurassic Age intrusives. A delineation diamond drilling program at the Mctush Property in the Port Alberni area was started in late 2000 on the Fred, Dave, Sy, Mc and Dauntless veins; it will be continued in 2001.

VALENTINE MOUNTAIN (092B 108, -075)

Beau Pre Explorations Ltd. commenced a small definition diamond drilling and trenching program on the Discovery Zone gold quartz vein target on their Valentine Mountain Property north of Sooke. Also, pulp materials from a prior bulk sampling program from the same zone was pilot plant tested using a small, dry-gravity separation system based in Vancouver. Beau Pre plans to use a similar system at Valentine Mountain during 2001 to process crushed gold quartz vein material from the trenching program. Additional blasting, trenching and drilling is planned for 2001.

BOLIVAR / YEW (092F 364, -516)

On northern Texada Island, 555 Corporate Ventures Ltd. completed bulk sampling and test milling

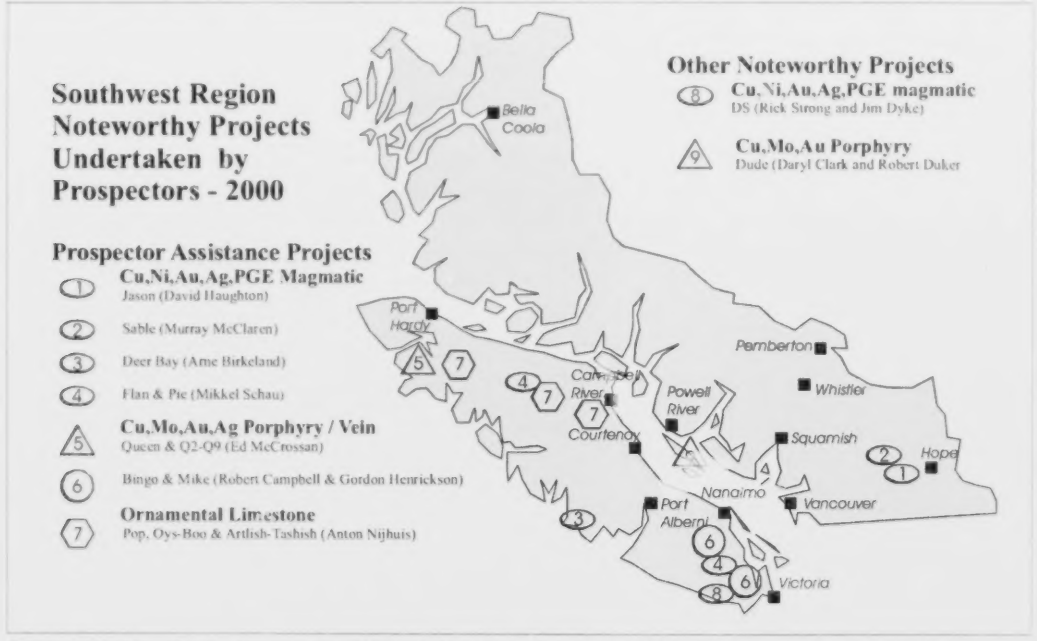


Figure 6. Southwest Region Noteworthy Projects -Undertaken by Prospectors, 2000

at its nearby Bolivar millsite of gold-bearing copper skarn material from the Yew Pit..

PROSPECTOR ACTIVITY

Near Jordan River on southern Vancouver Island, prospectors Rick Strong and Jim Dyke successfully located and re-excavated an old forestry quarry site on their DS Property. High grade chalcopyrite-bearing rock fragments had been discovered along several kilometers of forestry road by the prospectors under a previous Prospectors Assistance Program. The excavated quarry site is thought to be the source of the copper-rich rock fragments. Samples yielded similar metal grades and geochemical signatures as samples from the nearby Sunro Mine (092C 073), a past producer of copper, gold, silver and molybdenum.

On southern Texada Island, prospectors Robert Duker, Daryl Clark and George Martin, working for Northstar Mines, investigated both gold-bearing quartz vein mineralization at their Tak Property, and porphyry copper-molybdenum-gold mineralization at their Dude Property. The Dude Property covers both the Tex (092F 276) and Long B (092F 504) porphyry showings previously explored by Falconbridge Ltd. in the 1960s and 1970s.

PROSPECTORS ASSISTANCE PROGRAM

On Vancouver Island, five prospector/geologists were supported under the Prospectors Assistance Program during 2000 to work on a variety of metallic exploration targets in different areas. At his Deer Bay Property near Tofino, Arne Birkeland explored for magmatic Cu-Ni-Au-Ag-PGE mineralization on and around the former Tofino Nickel prospect (092F 029). Mikkel Schau staked and also sought magmatic PGE mineralization both at his Pie Property near Ladysmith, and at his Flan Property west of Campbell River. Ed McCrossan staked and explored for porphyry and related Cu-Mo-Zn-Au-Ag mineralization at his Queen and Q2-Q9 Properties west of Port Alice. Robert Campbell and Gordon Henrickson searched for Au-Ag-Cu-Mo Quartz vein mineralization around the Bingo showing (092B 077) at Cowichan Lake, and around the Mike showing (092C 129) near Chemainus. Prospector Anton Nijhuis explored and sampled ornamental limestone from his Oys, Boo and Pop Properties near Campbell River, and searched for dimension limestone across northern Vancouver Island. He also test-marketed fragments of the ornamental limestone.

LOWER MAINLAND

PORT DOUGLAS (092GNE 041, etc.)

Platinate Minerals and Industries Ltd. completed staking and preliminary exploration work on a very large property located along the west side of the Lillooet River Valley at the north end of Harrison Lake. The program targeted volcanogenic massive sulphide, porphyry copper-molybdenum-gold, gold-copper mesothermal quartz vein and gold-silver epithermal mineralization in the Cretaceous age Fire Lake Group. The Fire Lake Group forms a pendant in the Coastal Plutonic Complex and correlates with the Gambier Group, which hosts the former Britannia Mine (092G 003), a volcanogenic massive sulphide deposit. The Port Douglas Property covers 19 mineral and 2 placer MINFILE occurrences. One of these, the FM 3 / Snow (092GNE 041), is a disseminated polymetallic showing in tuff. Rock chip sampling yielded significant values of gold, silver, copper, lead and zinc. Additional work is proposed at Port Douglas in 2001.

HARRISON LAKE - HOPE AREA

In the Harrison Lake - Hope area, a mini-staking rush occurred this year northwest of the past producing Giant Mascot mine (092HSW 004, -093, -125), which is owned by Homestake Canada Inc. Over 750 mineral claim units were staked to cover this prospective area The primary exploration target was magmatic Cu-Ni-Au-Ag-PGE mineralization. Most of the claim units are within groups of properties staked by the following: Santoy Resources Ltd. at Emory Creek; partners John Chapman and Gerald Carlson at Cogburn; and David Deering at Harrison Lake. All plan preliminary exploration work in 2001.

PROSPECTORS ASSISTANCE PROGRAM

The Harrison Lake - Hope activity in year 2000 was predated by the success of prospecting geologist David Haughton, who was supported through the Prospectors Assistance Program in 1999. He continued work on and expanded his Jason Property during the year, targeting magmatic Cu-Ni-Au-Ag-PGE mineralization. Geologist Murray McClaren, supported by the 2000 Prospectors Assistance Program, staked and searched for similar mineralization on his Sable Property, located at the north end of the Harrison Lake - Hope area.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the contributions of numerous prospectors, the public, private sector geologists, and other professionals to this report. Without their support, exploration reviews such as this would not be possible.

SOUTH-CENTRAL REGION

By Michael S. Cathro, P. Geo.
Regional Geologist, Kamloops

SUMMARY

- Exciting new stratiform base-metal massive sulphide discoveries were made on the **Fox** property (Photo 1) near Merritt, on the **Spire** claims north of Revelstoke, and on the **Broken Hill** property near Blue River.
- Large drilling programs were mounted on the **Afton** and **Ann North** porphyry copper-gold projects.
- Construction of the **Ashcroft** roofing granule plant of I.G. Machine and Fibers took place during the year. Quarrying and plant start-up are slated for mid-2001.
- Exploration activity rebounded slightly in 2000 with $3.5 million in spending (vs. $2.5 million in 1999), 20 000 metres of drilling (versus 12 000 metres) and 8 major projects (versus 7).
- Claim staking was relatively strong, with over 6700 new mineral claim units recorded (versus 5600 in 1999). A mini-staking rush around the Fox discovery between Merritt and Kamloops (1450 units) was partly responsible for the increase.

EXPLORATION TRENDS

Exploration indicators for the South-Central region improved moderately in year 2000. Exploration and development spending (Figure 1), metres of drilling (Figure 2), and number of major projects (Figure 3) were all up. Exploration spending for 2000 is estimated at $3.5 million while drilling activity increased to about 20 000 metres. There were eight major exploration projects (Table 1 and Figure 5).

Large drilling campaigns on the Afton mine and Ann North porphyry copper-gold projects, and renewed interest in stratiform, base-metal massive sulphide targets triggered by the new discoveries stimulated this improvement. Higher prices for platinum group metals (PGMs) resulted in one major project (Clearwater) and grassroots work on several properties, and increased interest is anticipated in the coming year. Junior companies again led the way in exploration spending, although major companies including Teck Corp., Rio Algom Inc., Highland Valley Copper, Imperial Metals Corp. and Inmet Mining Corp. were also active.

A total of 6755 claim units were staked in the region between January 1 and December 31, 2000, the highest annual figure in the last ten years (Figure 4), and forfeited claims were down to 4333 units. This resulted in a net 50 000 hectare gain in good-standing tenure in the region.

Photo 1. Gitennes Exploration Inc. geologists at the Blacktop zone (Fox property) beside the Coquihalla highway north of Merritt. Massive sulphide mineralization occurs in the cut.

MINES

The **Highland Valley Copper** (HVC) operation (Photo 2), a partnership of Cominco Ltd. (50%), Billiton Plc. (33.6%), Teck Corp. (13.9%) and Highmont Mining Co. (2.5%), expects to produce a record amount of copper in year 2000.

Mining low-grade porphyry copper-molybdenum-gold-silver ore, the operation employs about 950 people. During the year the HVC bene-

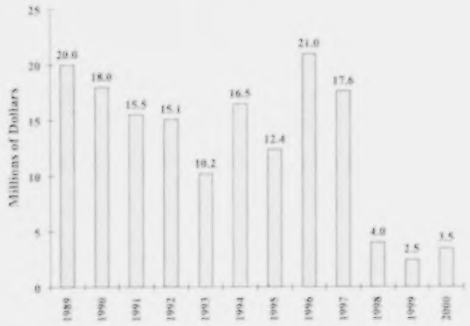


Figure 1. Annual exploration spending, in millions of dollars, South-Central Region.

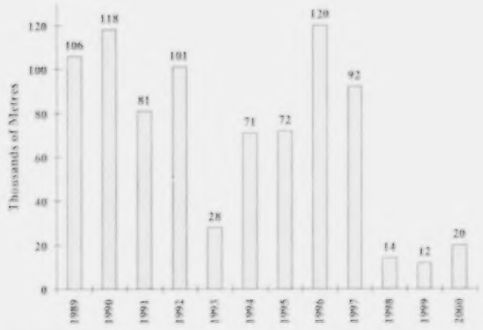


Figure 2. Annual exploration and development drilling, in thousands of metres, South-Central Region.

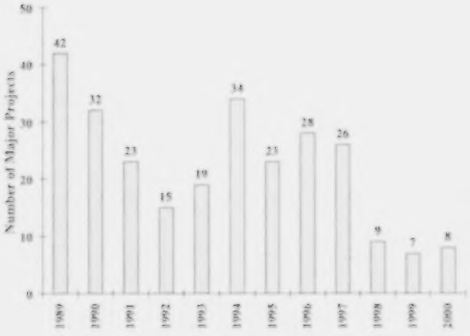


Figure 3. Number of major exploration projects per year, South Central Region. Major projects are those with mechanical disturbance (e.g. trenching or drilling) and expenditures exceeding $100 000.

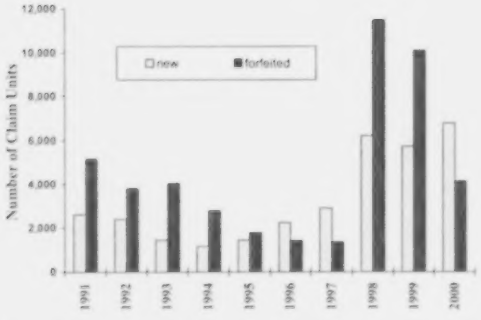


Figure 4. Number of new claims units staked versus claim units forfeited per year, South-Central Region. Source: Mineral Titles Branch.

fited from higher copper prices, a substantial increase in production and sales, and a three per cent reduction in operating costs compared with unit costs prior to the May-September 1999 shutdown. Mine closure is forecast for March, 2009 based on remaining reserves, although the feasibility of a three year extension is being studied. This would involve a push back of the southeastern pit wall and deepening the Valley pit. In terms of exploration, HVC completed a large IP survey south of the Highmont mine in 2000, and $250 000 in "faint hope" exploration spending is budgeted for 2001 (Kamloops Daily News, December 21, 2000).

For its 50 per cent share in the mine, Cominco Ltd. reported a $36 million operating profit on revenue of $227 million for 2000. Total production for the year for the mine was 190 600 tonnes of copper metal, 2000 tonnes of molybdenum metal, 2 262 400 ounces of silver and 15 800 ounces of gold contained in concentrate (Cominco Ltd., Fourth Quarter Report, January 31, 2001).

Numerous small to medium-sized industrial mineral quarries operated throughout the region during the year (Figure 5). The Kamloops cement plant and **Harper Ranch** limestone quarry of Lafarge Canada Inc. operated intermittently, producing about 115,000 tonnes of cement, or roughly 50 per cent of capacity. Lafarge also draws materials from the **Falkland** (gypsum) and **Buse Lake** (silica-alumina rock) quarries. In 2001, production at the Kamloops plant is forecast to be about 60 to 70 per cent of capacity. At **Pavilion** near Lillooet, Graymont Western Canada Inc. (formerly Continental Lime Ltd.) operates a limestone quarry and lime kiln. The operation

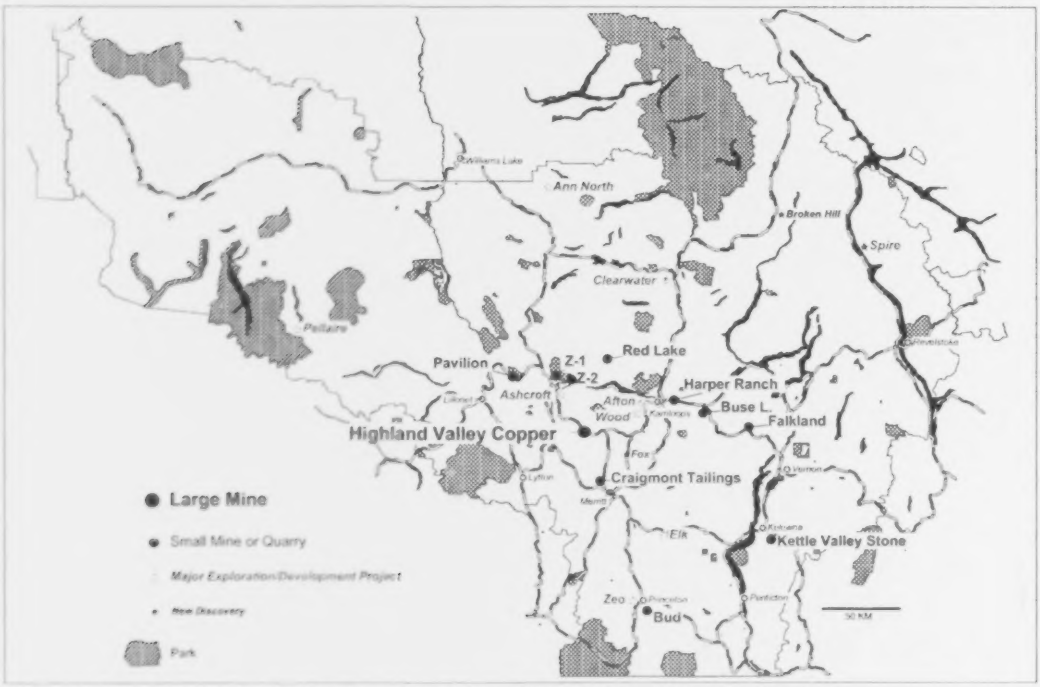


Figure 5. Operating mines, major exploration projects and new discoveries, South-Central Region. 2000.

Table 1. Major Exploration Projects, South-Central Region, 2000.

Property	Operator	NTS	MINFILE #	Commodities	Target/Deposit Type	Work Done
Afton Mine	DRC Resources Corp.	92I/10E	092INE023	Cu, Au, Pd, Ag	Alkalic Porphyry	22 ddh, approx. 8500 m
Ann North	GWR Resources Inc.	92P/14W	092P115	Cu, Au	Porphyry	25 ddh, 5051.2 m; geol
Clearwater (Golden Loon)	Cusac Gold Mines Ltd.	92P/08E	N/A	Pt, Pd, Au, Cr	Ultramafic	230 m trenching; IP, 11 km geochem
Elk (Siwash North Mine)	Fairfield Minerals Ltd.	92H/16W	092HNE096	Au, Ag	Vein	12 ddh, approx. 1400 m; prosp; geochem
Pellaire	Zelon Chemicals Ltd.	92O/04E	092O/045	Au, Ag	Vein	Bulk sample
Spire	Imperial Metals Corp.	82M/10E	082M278	Cu, Zn, Ag	VMS	7 ddh, 720 m; geol; prosp
Wood	Lakewood Mining Co. Ltd.	92I/09W	092INE165	Cu	Alkalic Porphyry	5 ddh, 1417.93 m
Zeo (Bromley Vale)	Zeo-Tech Enviro Corp.	92H/07E	092HSE166	Zeolite	Industrial Mineral	2200 tonne bulk sample; engineering and marketing studies

Photo 2. Blast in Valley pit, Highland Valley Copper.

produces about 200 000 tonnes of lime per year, mainly for use in pulp mills. Near Merritt, M Seven Industries Ltd. produces magnetite on an intermittent basis by reprocessing tailings from the old **Craigmont** copper mine. The magnetite is used in coal washing plants throughout western Canada.

Western Industrial Clay Products Ltd. operates the **Red Lake** quarry which supplies diatomaceous earth for its plant in Kamloops. The company produces kitty litter, barn deodorizer and other industrial absorbents. Bentonite from the **Bud** quarry at Princeton is used as a clumping agent in some of the company's products. Western Industrial Clay is also evaluating the feasibility of mining and selling "leonardite" or "humate" soil conditioner from a humic acid-bearing, carbonaceous layer which occurs between two diatomaceous earth layers in the Red Lake quarry.

The Mountain Minerals Division of Highwood Resources Ltd. owns the **Z1** zeolite quarry near Cache Creek. Intermittent production from the quarry supplies the agri-food and industrial absorbents markets. A few kilometres to the east, C_2C Zeolite Corp. mines zeolite-bearing shale from the **Z2** quarry, and processes the rock into various absorbent products at its plant in Ashcroft. Fourth-quarter sales were reported by the company to be up to 620 tonnes, however, this figure includes an undisclosed tonnage sold from the company's operation in Nova Scotia. Deodorizers, feed binders, cat litter and industrial absorbents are sold in bulk and bagged form under the trade names *Muckers Mate*, *Cage*, *Cage T408* and *Zippity Doo*. The company is also developing a commercial process for producing lightweight zeolite concrete.

At Kelowna, The Kettle Valley Stone Company, a subsidiary of L. & D. Petch Contracting Ltd., expanded production of its flagstone, facing stone, ashlar and landscape rock products from the nearby **Nipple Mountain** (photo 3), **Canyon** and **Gemini** quarries. These quarries produce the "Mountain Ash" "Rainbow granite" and "Shadow Ridge" product lines from Tertiary dacite ash, Okanagan gneiss, and Tertiary columnar basalt respectively. Perhaps most significantly, Kettle Valley has developed a technique to produce lightweight "thin-veneer" wallstone (Photo 4) using all of its different rock types. The thin veneer product includes corner pieces and

Photo 3. Nipple Mountain dacite ash quarry, Kettle Valley Stone Company..

is reported to compare favourably, both in terms of cost and ease of installation, with imitation or "cultured" stone products. Kettle Valley employs between ten and twenty people in quarrying, plant and sales jobs.

During the year, the dormant **Similco** porphyry copper-gold mine and mill complex at Princeton and the Invermay project near Hope were purchased by Leader Mining International Inc. from Imperial Metals Corp. At the time of writing, Leader has paid $350,000 with a final $700,000 payment due on February 28, 2001. Upon closing Leader will have a 100% interest in both projects with Imperial retaining a 3% net smelter return. According to Imperial, Similco has a resource of 142 million tonnes grading 0.397% copper in the area of pits 2 and 3 on the Copper Mountain side of the property. Leader plans to conduct a $3 to $5 million study over the next 12 to 18 months to see if it is feasible to restart the mine, which has been on care and maintenance since September, 1996.

Photo 4. Thin veneer corner piece, Kettle Valley Stone Company.

The dormant **Blackdome** gold-silver mine of Claimstaker Resources Ltd. remains on care and maintenance after operating briefly from October, 1998 to May 1999. The mine closed due to low gold prices, poor recoveries and downward revision of the estimated proven and probable reserves (Claimstaker Annual Report, 1999). In 2000, the company wrote down the value of the property and removed camp buildings. The 200 tonne-per-day mill remains on site in anticipation of an improvement in the price of gold and future exploration for additional reserves.

DEVELOPMENT PROJECTS

Development of the 250 000 tonne per year **Ashcroft** basalt quarry and roofing granule plant proceeded throughout the year. Work mainly comprised plant construction. Initial quarrying and plant start-up are scheduled for mid-2001. The project is owned by I.G. Machine and Fiber Ltd., a subsidiary of IKO Industries Ltd., one of the largest roofing shingle manufacturers in Canada. Roofing granules will be produced from Nicola Group basalt. The basalt will be crushed and sized on site, and the granules will then be coloured (painted) with different hues prior to being shipped to IKO shingle plants in Calgary and Sumas, Washington. The company estimates the operation will employ 40 to 60 people once full production is attained.

On the **Zeo** claims at Princeton, Zeo-Tech Enviro Corp. mined a 2200 tonne bulk sample of zeolite from the Bromley Vale deposit. The company has applied for a mining lease and is preparing a permit application for a 100 000 tonne per year quarry and micronizing plant. Zeo-Tech has formed a joint venture with C_2C Zeolite Corp. for research and development of agricultural and industrial uses for its zeolites.

Also near Princeton, the **Tulameen** thermal coal project of Pacific West Coal Inc. received a permit to operate a 100 000 tonne-per-year open-pit mine and washing plant. A ten tonne sample was shipped to Calgary for washability studies. Logging of part of the site took place late in the year, and the company plans to extract a 5000 tonne bulk sample during 2001. The proposed mine is located directly north of, and on strike from, the former producing, Blakeburn Collieries (1912-1954), which produced from underground and open-pit workings. The coal is high volatile bituminous B and C in rank and the company reports that preliminary studies indicate that it can be cleaned to produce a product with acceptable levels of ash, moisture, sulphur and energy content. Potential markets are industrial users in the Lower Mainland, Northwestern United States and overseas. The project could initially employ up to 30 people.

The **Prosperity** gold-copper porphyry deposit of Taseko Mines Ltd., is located southwest of Williams Lake. An environmental review of the project under the British Columbia and Canadian Environmental Assessment Acts has been stalled since mid-1998, and the company is now focused on restarting its Gibraltar copper mine north of Williams Lake. Prosperity reserves stand at 633 million tonnes grading 0.253% copper and 0.466 g/t gold. Recent feasibility work suggests the project could operate at a milling rate of 70 000 tonnes per day with an operating life of 19 years.

There was no activity on the **Getty North** porphyry copper deposit of Getty Copper Corp., although a $430 000 financing was completed late in the year. The deposit is estimated to contain a resource of 72.1 million tonnes grading 0.31% copper, which includes a higher grade oxide resource of 10.0 million tonnes grading 0.40% copper. Getty plans to restart a feasibility study on mining and processing of the oxide resource by the solvent extraction - electro-winning (SX-EW) process.

Quinto Technology Inc. (formerly The Quinto Mining Corp.) continued with efforts to raise funds

to develop its 75 000 tonne per year graphite-sericite project at **Lumby**.

EXPLORATION PROJECTS

STRATIFORM BASE-METAL TARGETS

Exciting new discoveries were made on the Spire, Fox and Broken Hill properties in year 2000. All three will receive drilling in 2001 and additional staking and grassroots prospecting is expected nearby.

Besshi-type VMS copper-zinc mineralization was the focus of a grassroots prospecting program by Imperial Metals Corp. near the dormant **Goldstream** mine, north of Revelstoke. The company evaluated possible Goldstream-equivalent stratigraphy on the **Spire** claims, and discovered a potentially significant new copper-zinc-silver showing 7.5 kilometres southwest of the Goldstream mill. The showing was found on a new logging road in September, 2000 by Craig Lynes, a prospector contracted by Imperial. Grab samples ran up to 8.03% copper, 7.89% zinc and 51 g/t silver. Seven drill holes tested the showing late in the fall; the best intersections were 3.12 metres grading 0.51% copper and 1.08% zinc, and 3.7 metres grading 0.24% copper and 1.49% zinc. Additional drilling is planned for 2001.

The discovery is exciting because the mineralization is similar to Goldstream ore and the geological setting is similar that of the Goldstream deposit. In addition, a new orebody could easily be brought into production using the existing mothballed mill, which is said to be in good condition. Goldstream operated from 1983 to 1984 and between 1991 and 1996, milling 2.21 million tonnes at a recovered grade of 3.54% copper, 0.36% zinc, and 11.86 g/t silver.

The **Fox** claims, covering a new, high-grade copper-zinc massive sulphide showing, were staked in July by prospector/geologist Michael Moore. The property was quickly optioned by Gitennes Exploration Inc. who quietly staked a large block of claims covering perceived favourable stratigraphy. Now called the "Blacktop zone", the prospect is located in a roadcut on the west side of the Coquihalla highway, 27 kilometres north of Merritt (Photo 1). Mineralization has been traced in outcrop and rubble for 90 metres along a north-south direction. It is covered to the south by rip rap, and to the north plunges under the highway. Hand trenching in the fall exposed a 1 to 1.3 metre-thick, west-dipping massive sulphide layer that assayed 17% zinc, 1.6% copper, 0.47% lead, 76 g/t silver and 0.49 g/t gold across 1.1 metres. The massive sulphide is associated with sericite-carbonate alteration and is overlain by chert and barite. Host rocks are intermediate (and felsic?) volcanic rocks of the Western volcanic facies of the Upper Triassic Nicola group (Moore and Pettipas, 1990). Gitennes carried out a 526 line-kilometre airborne magnetic and electromagnetic survey, conducted geological mapping, and sampled stream sediments throughout the property. Subsequently, they carried out detailed IP and EM surveys in the area of the showing.

A small staking rush followed announcement of the Fox discovery, and by year end nearly 1450 claim units had been staked on the 92I/02 and 07 mapsheets. The largest land positions were acquired by Gitennes Exploration Inc., Fjordland Minerals Ltd. and Platinova A/S. Several other companies or individuals also staked key ground including Lloyd Addie, who staked the **LD** barite-gold-silver-zinc-lead-copper prospect at Iron Mountain, and Lorne Warner who staked the **Iron King** iron prospect south of Nicola Lake. To the south near Tulameen, the **Cousin Jack** showing (Rabbitt Mountain) and several other possible VMS prospects in the Nicola group were staked.

The **Broken Hill** property, located seven kilometres northeast of the village of Avola on the North Thompson River, was staked in September, 2000. It covers a series of new zinc-lead-silver prospects found by prospector/geologist Leo Lindinger, who was supported by the provincial Prospectors Assistance Program. In September, Lindinger optioned the property to Cassidy Gold Corp. who conducted additional prospecting, soil sampling and a gravity survey to define targets for an initial drill program in early 2001. The property covers the Vista, Navan and Mike prospects which are exposed by new logging road cuts along a 5.5 kilometre northerly trend (Photo 5). Mineralization occurs in highly metamorphosed sedimentary rocks and consists of thin (20-35 centimetre) layers of massive sphalerite, galena and pyrite adjacent to marble (locally altered to skarn near pegmatite dikes) and pyritic quartzite. Grab samples run up to 24.3% zinc, 4.89% lead and 62.6 g/t silver. The mineralization is very similar in setting and metal content to other nearby Shuswap-type occurrences such as Ruddock Creek and CK, which occur less than 25 kilometres to the east and west respectively. At those deposits, local thickening on

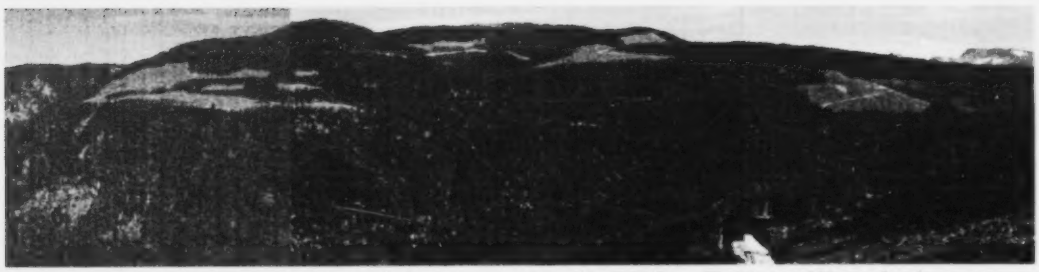


Photo 5. Panorama of the Broken Hill zinc-lead-silver property of Cassidy Gold Corp. The Vista and Navan showings occur along the road at the bottom of the left-hand and right-hand logged areas respectively.

fold noses created wider zones where modest tonnages of potentially ore-grade mineralization have been defined.

Teck Corporation's **Red Hill** property, located near Ashcroft, was explored with a small EM survey, whole rock geochemistry and geological mapping. Previous drilling on the property by BP Selco intersected 7.7 metres of VMS-style mineralization grading 2.5% copper, 2.8% zinc, 77 g/t silver, 0.37 g/t Au. The property is underlain by a package of Lower Triassic bimodal volcanics and sediments cut by, synvolcanic diorite. Recently, this package has been interpreted to be equivalent to the Kutcho Assemblage of northern British Columbia (Childe et al., 1997).

PORPHYRY AND RELATED TARGETS

Over half the spending in the region in year 2000 targeted porphyry deposits . West of Kamloops, deep drilling beneath the **Afton** pit was conducted by DRC Resources Corp. (Photo 6) The former Teck Corporation copper-gold mine operated from 1977 to 1987, after which production came from the nearby Crescent, Pothook and Ajax pits. The Afton-Ajax operation was permanently closed by Teck in 1997 and reclamation of the site is ongoing. Much of the mining and milling equipment has been sold, although the mill building and heavy mill machinery are still on site.

After Teck let its mining lease lapse in 1999, the Afton-Pothook portion of the property was re-staked and optioned to DRC. DRC's work this year tested the down plunge extension of the steeply southwest-plunging Afton orebody beneath the pit bottom, a zone which had been previously tested by only ten holes drilled by Afton Mines/Teck Corp. in 1973 and 1980. These holes indicated a resource of 10.5 million tonnes grading 1.52% copper and 0.03 g/t gold, and in-house scoping studies in the 1980s evaluated the potential economics of mining the zone using bulk underground mining methods.

The DRC drilling, totaling some 8000 metres in 22 holes by year end, appears to confirm and expand the previous Teck-defined resource. Most of the 2000 holes were drilled subparallel to the mineralized zone and had impressive intersections. Hole 2K-2, for example, cut 234.9 metres grading 2.37% copper, 1.1 g/t gold, 0.1 g/t palladium, and 0.89 g/t silver. Mineralization comprises mainly bornite and chalcocite with minor chalcopyrite and native copper. Much of the better mineralization is hosted in a breccia zone with volcanic and intrusive fragments and gouge. Early in 2001, DRC announced that it had hired Behre Dolbear and Company Ltd. to undertake a scoping study to evaluate mining, processing, infrastructure and permitting considerations, and to provide an estimate of capital and operating costs for an underground mine at Afton.

Photo 6. Diamond drill (lower left) in the Afton pit.

On the **Ann** claims (Ophir Copper property) northeast of Lac La Hache, GWR Resources Inc.

drilled 25 holes totaling 5051 metres on the **Ann North** porphyry copper-gold prospect and adjacent targets. The Ann North mineralization consists of chalcopyrite, pyrite, bornite, chalcocite and minor native copper in fractures, veinlets and breccias hosted by porphyrytic monzonite. Pervasive potassium feldspar flooding, quartz and tourmaline veining, and local biotite and sericite alteration have also affected the rock (GWR Resources Inc. News Release, January 15, 2001). The best hole, DDH-00-15, had an intersection of 0.20% copper and 0.30 g/t gold over 125 metres, and many of the other holes had anomalous copper or gold values.

Dave Ridley, a Prospectors Assistance grantee, conducted soil sampling and prospecting on the **Fox 1 to 6 claims** north of Canim Lake and 25 kilometres east of the closed Boss Mountain molybdenum mine. Ridley further outlined an interesting new molybdenum-tungsten-zinc skarn prospect which he discovered late in the 1999 field season. Mineralization consists of coarse-grained molybdenite, lesser scheelite, pyrite, sphalerite and rare chalcopyrite hosted in garnet-diopside-quartz-vesuvianite skarn and in quartz veins cutting the skarn. Grab samples from scattered outcrop exposures returned values of up to 3% molybdenum and 1.6% tungsten from subcrop and float boulders over about 1000 metres of strike length.

VEIN TARGETS

Lower gold prices in recent years reduced interest in precious metal vein deposits. Nevertheless, several properties were active. Twelve holes were drilled on the **Elk** property, located east of Merritt, by Fairfield Minerals Ltd. The drilling tested the extension of the Siwash North vein and several other narrow, high-grade gold-silver veins hosted in granitic rocks. Production from the Siwash North vein between 1992 and 1994 totaled more than 51,000 ounces gold.

At the **Pellaire** gold-silver project, located southwest of Williams Lake, Zelon Chemicals Ltd. conducted surface mining from the number 3, 4 and 5 veins. The material was stockpiled at the site of small gravity concentration plant which is being constructed for operation in 2001.

At East Barriere Lake, north of Kamloops, the **Pongo** property of Larry Ovington was optioned by Verdstone Gold Corp. and Molycor Gold Corp. The claims cover the Kajun showing (MINFILE 82M058), a polymetallic vein hosted by a thrust fault in Eagle Bay Assemblage volcanic and sedimentary rocks. Chip samples collected by consultant D. Blanchflower assayed up to 5.8 g/t gold, 263 g/t silver, 9.75% lead, 7.89% zinc and 0.24% copper over two metres. The high precious metal grades of the mineralization and its association with a thrust fault suggest a similar setting to the Samatosum mine, 13 kilometres to the south.

Working on a Prospectors Assistance Grant, Gary Polischuk (Photo 7) searched for mesothermal gold-silver veins on the **Dave claims**, located on Mt. Brew, 8 kilometres southeast of Lillooet. Diligent prospecting located several new areas where visible gold is present in float of quartz-sulphide vein material or where gold can be panned from rusty soil. The new occurrences are locally associated with zones of iron carbonate-silica-mariposite (listwanite) alteration.

Photo 7. Prospector Gary Polischuk examining quartz veins on the Dave claims near Lillooet.

MAGMATIC TARGETS

The strong increase in the price of platinum group metals in 2000 resulted in increased exploration and grassroots prospecting for these metals, primarily in ultramafic rocks. The **Dobbin** property at Whiterocks Mountain northwest of Kelowna was

expanded through staking in early 2000. The claims, which are owned by Molycor Gold Corp. and Verdstone Gold Corp., cover the Whiterocks complex, a multiphase mafic alkalic complex. Drilling in 1997 intersected numerous wide zones of low-grade copper-platinum-palladium mineralization. The best hole, 97-21, intersected 111 metres grading 0.19% copper, 0.410 g/t platinum and 0.352 g/t palladium, including 15 metres grading 0.54% copper, 1.316 g/t platinum and 0.949 g/t palladium. Work in 2000 included prospecting, geological mapping and soil surveys which resulted in discovery of a new mineralized zone, which has not yet been tested with drilling or trenching.

Cusac Gold Mines Ltd. explored the **Clearwater Platinum** property (Golden Loon claims) near Little Fort with an excavator trenching program, and IP, VLF, magnetic and geochemical surveys. The property covers a six to ten kilometre-long, compositionally zoned, ultramafic body which occurs between the Upper Triassic Nicola Group and the Lower Jurassic Thuya batholith. The year 2000 work was designed to evaluate the PGM potential of the central part of the ultramafic complex, and to follow-up on a sample of dunite rubble from a road deactivation trench, collected by J.D. McDougall in 1999, which assayed 13.7 g/t platinum. Numerous chargeability and soil anomalies (nickel, cobalt, chromium, platinum and gold) were outlined by the 2000 work and these will be tested by a 1500 metre drill program in 2001.

ACKNOWLEDGEMENTS

The generous contribution of data and ideas by the exploration community is greatly appreciated. The manuscript benefited from the editorial comments of Bill McMillan.

REFERENCES

Childe, F.C, Friedman, R.M., Mortenson, J.K., and Thompson, J.F.H. (1997): Evidence for Early Triassic Felsic Magmatism in the Ashcroft (92I) Map Area, British Columbia, in Geological Fieldwork 1996, B.C. Ministry of Energy and Mines, Paper 1997-1, pages 117-124.

Moore, J.M. and Pettipas, A.R., (1990): Geological Studies and Mineral Occurrences in the Nicola Lake Region, British Columbia (92I/SE), B.C. Ministry of Energy, Mines and Petroleum Resources, Open File 1990-29.

KOOTENAY REGION

By Paul Wilton, P. Eng.
Regional Geologist, Cranbrook

SUMMARY

Exploration expenditures in the Kootenay region in 2000, including those at the operating coal mines, are estimated to have totaled about $6.5 million, a reduction of 7% from the corresponding estimate for 1999 (Figure 1). Of that total, approximately $1.9 million was spent on exploration drilling for coal at, or in the vicinity of, the five producing coal mines in the Elk Valley, an increase of about 19% from 1999. This reflects renewed optimism and plans for increased production by the coal mines. In contrast, expenditures on exploration for metals and industrial minerals decreased by roughly 15% in the year 2000.

This significant reduction in activity by the non-coal sectors is demonstrated most clearly by the dramatic drop in the recorded number of individual projects (mineral, coal, and placer) to 97 from a total of 171 in 1999 (Figure 2). The total amount of exploration drilling increased from about 61 000 metres in 1999 to an estimated 70 300 metres in 2000 (Figure 3), but that, again, reflects the higher level of activity by coal companies.

In 1999, when non-coal exploration was heavily focused on a search for Sullivan-style sedex deposits in Purcell Supergroup rocks, the distribution of major projects was skewed toward the eastern part of the region. In 2000, however, the distribution was more balanced between the West and East Kootenay sub-regions (Figure 4). The search for a successor to the Sullivan mine has slowed noticeably, fewer projects were underway and only one major company, Rio Algom Exploration Inc., performed most of the recorded drilling. In fact, in the last half of the year Chapleau Resources Ltd., which has been one of the main junior company participants in the sedex search, redirected its efforts to exploration for beryllium and other industrial commodities in pegmatites that intrude the Purcell rocks. In contrast, the Salmo and Nelson areas, west of Kootenay Lake, saw increased activity in 2000. Redhawk Resources Inc. and ZincOx Resources aggressively explored occurrences of zinc oxide mineralization in the Kootenay Arc, and the Lang Group of companies were encouraged by results attained from two bulk mineable gold prospects, Kena and Rozan, south of Nelson.

Interest in industrial minerals remained high. Progress was made in 2000 toward potential development of flake graphite and gemstone resources in the Slocan Valley, as well as barite veins at Jubilee Mountain west of Spillimacheen, and a large gypsum resource, belonging to Westroc Inc., which straddles the Kootenay River northeast of Canal Flats.

As mentioned previously, the pace of resource definition drilling at the coal mines in the Elk Valley increased in 2000. New market contracts are being achieved, optimism is high, and all the mines plan increased production in 2001. Cominco Ltd. announced that the Sullivan zinc-lead-silver mine at Kimberley, which is the only producing metal mine in the region, will close permanently at the end of 2001. All the major industrial mineral mines and quarries that were in operation at the start of the year (see Figure 5), maintained steady production through the year and no change is forecast for 2001. There were no mine closures in the region during the year, no new mines opened and none were being developed.

EXPLORATION HIGHLIGHTS

Table 1 details major metal, industrial mineral and coal projects in the region in year 2000. The projects listed are those which involved significant expenditures on exploration drilling, bulk sampling or underground exploration work. Locations of these major projects, plus some smaller ones that are believed to have particular regional significance, are shown on a map of the region (Figure 4). There were 12 projects with reported expenditures of $100 000 or more and one, Bull River, is believed to have spent more than $1 million (the actual expenditure on exploration activities at Bull River is unknown and has been arbitrarily set at $1 million for statistical purposes).

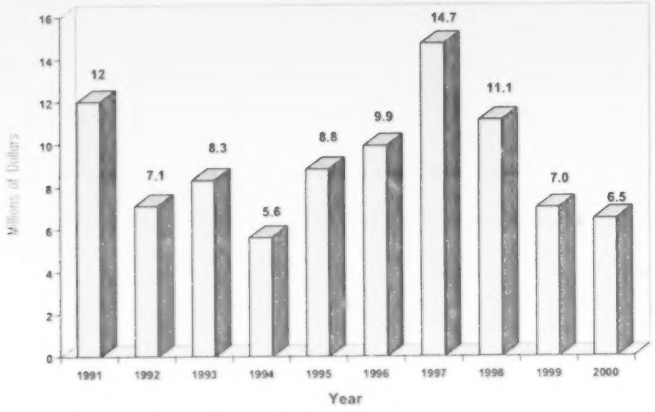


Figure 1. Exploration Expenditures, Kootenay Region.

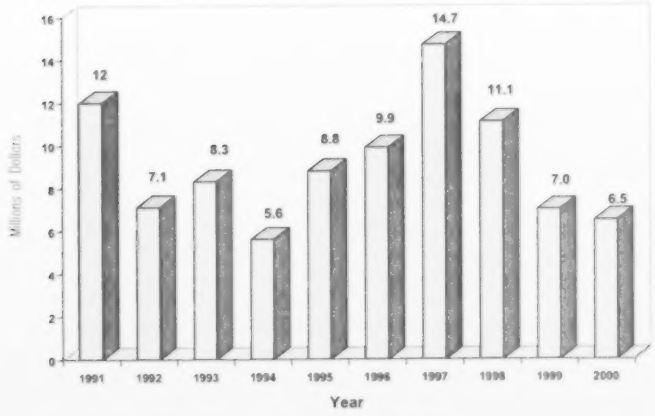


Figure 2. Exploration Projects, Kootenay Region.

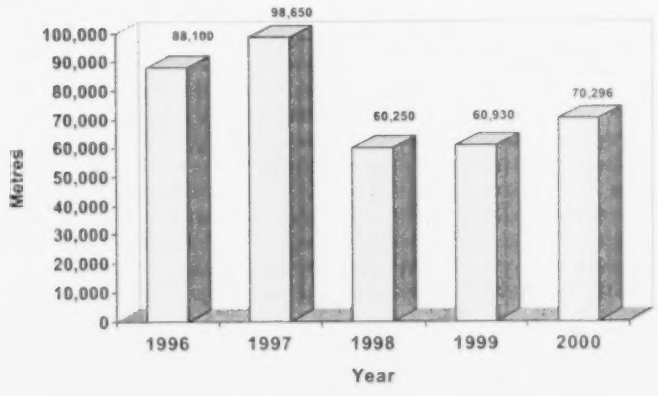


Figure 3. Total Drilling., Kootenay Region.

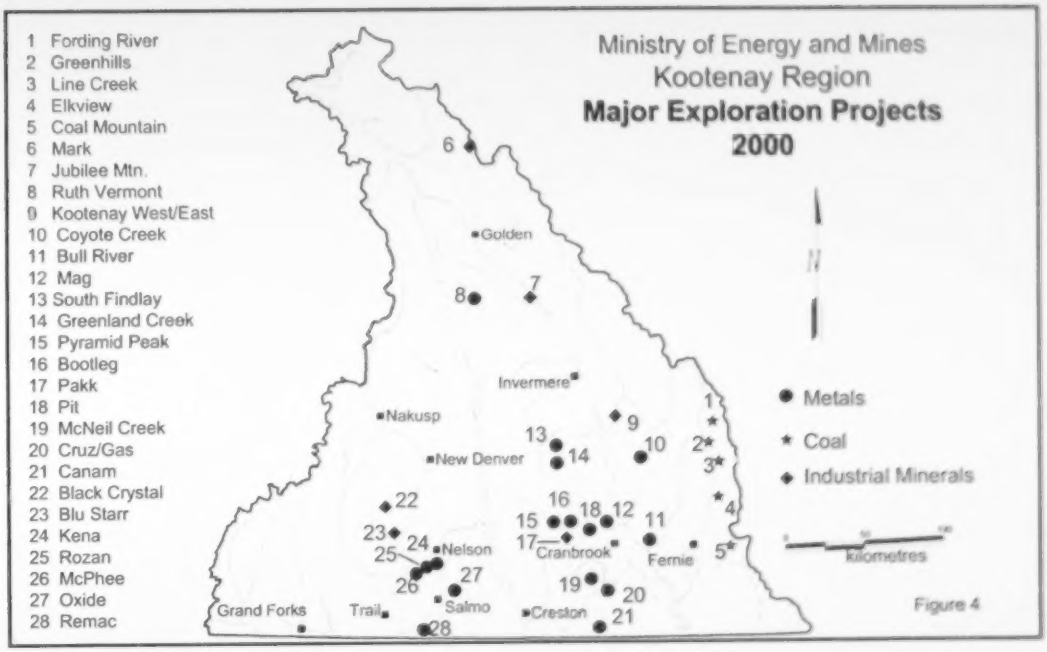


Figure 4. Major Projects, Kootenay Region, 2000.

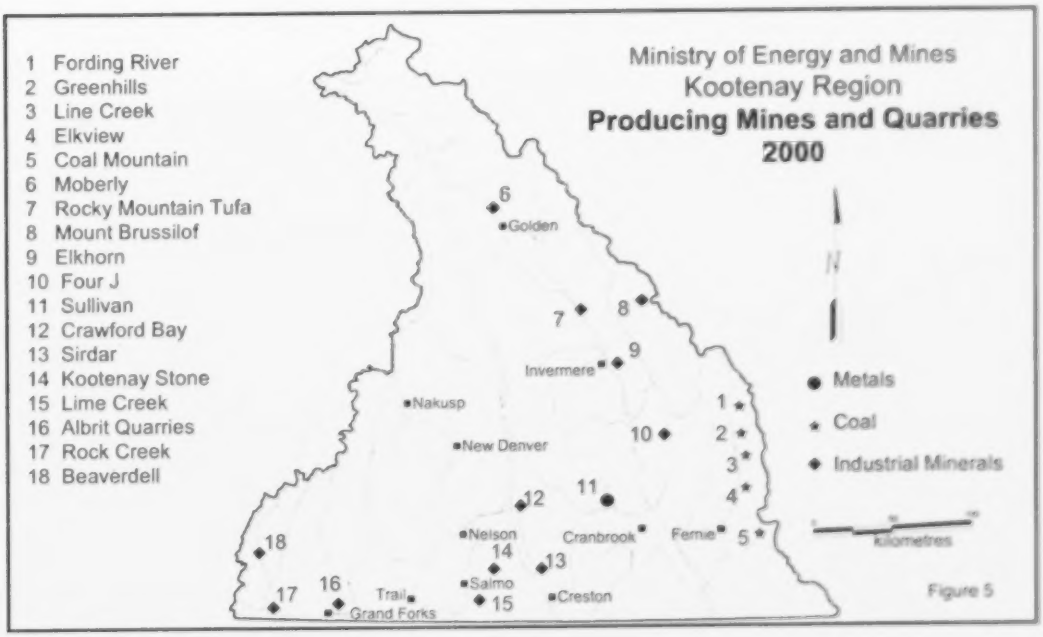


Figure 5. Producing Mines and Quarries, Kootenay Region, 2000.

Table 1. Major Projects, Kootenay Region, 2000.

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Black Crystal (Crystal Graphite Corp.)	082FNW260	Slocan	82F/13W	Graphite	Metamorphic	bulk samp.; geophys.; ~1000m diamond drilling
Blu Starr (Hampton Court Res./ Anglo Swiss Res.)	082FNW259	Slocan	82F/12E	Gemstones	Metamorphic	Prospecting; geol.; geophys.; bulk samp.;market testing
Bull River (R.H. Stanfield Group)	082GNW002	Fort Steele	82G/11W	Cu, Ag, Au	Mesothermal Veins	u/g drift'g & sampling;
Coal Mountain Mine (Fording Coal Ltd.)	082GSE052	Fort Steele	82G/7E, 10E	Coal	Coal	21 rcdh, 5165m
Elkview Mine (Elkview Coal Corp.)	082GNE015	Fort Steele	82G/10W, 15W	Coal	Coal	7150m rc drilling
Fording River Mine (Fording Coal Ltd.)	082JSE009, 010, 012	Fort Steele	82J/2W	Coal	Coal	6750m rc drilling
Greenhills Mine (Fording Coal Ltd.)	082JSE001, 005, 007	Fort Steele	82J/2W	Coal	Coal	4237m rc drilling
Greenland Creek (Kennecott Canada Exploration Inc.)	082FNE089, 107, 112	Fort Steele, Golden	82F/16E	Zn, Pb, Ag	Sedex	1 ddh, 295m
Jubilee Mountain (WWC Consulting Ltd.)	082KNE079	Golden	82K/16W	Barite	Veins, breccias	diamond drilling
Kena (Sultan Minerals Inc.)	082FSW237, 331, 332	Nelson	82F/6W	Au, Ag, Cu	Porphyry	trenching; geochem.; geophysics
Kootenay West/East (Westroc Inc.)	082JSW005	Golden	82J/4E	Gypsum	Evaporite	diamond drilling
Line Creek Mine (Luscar Ltd.)	082GNE020, 021, 022	Fort Steele	82G/15W, E	Coal	Coal	25 000m rc drilling
Pakk/Pit (Chapleau Res. Ltd.)	082FNE054, 061, 062, 101, 110	Fort Steele	82F/9E,W	Be, Rb, Ta, REE,	Pegmatite,	14 ddh, ~4540m
Pyramid Peak (Rio Algom Exploration Inc.)	082FNE064, 087	Fort Steele	82F/9E	Zn, Pb, Ag	Sedex	2 ddh, 1553m
Remac (Redhawk Res. Inc./ ZincOx Resources)	082FSW024, 026, 219	Nelson	82F/3W	Zn, Ag, Pb (oxides)	Sedex, replacement (weathered)	21 rcdh, ~2600m; trenching
Ruth Vermont (MineQuest Explor'n Associates Ltd.)	082KNE009, 010, 011, 037	Golden	82K/15W	Ag, Pb, Zn, Au	Vein, Sedex	5 ddh, 1050m
South Findlay (Rio Algom Exploration Inc.)	082KSE 041, 053, 063	Golden	82K/1E	Zn, Pb, Ag	Sedex	3 ddh, 2579m

METALS

PURCELL ANTICLINORIUM

Exploration for Sullivan-style sedimentary exhalative (sedex) zinc-lead-silver mineralization in the Purcell Mountains, the main focus of activity and expenditure in the region in 1999, decreased significantly in 2000. The search focuses on rocks of the Middle Proterozoic Aldridge Formation of the Purcell (Belt) Supergroup which occur in the core of a north-plunging anticlinorium located east of Kootenay Lake. Approximately $1.3 million was spent on exploration for Sullivan-type targets, compared to about $2 million in 1999. However, during 2000, more than 60% of the expenditures were by Rio Algom Exploration Inc. which carried out deep stratigraphic drilling on three properties. A few other projects were active in the play, but most involved only one drill hole or limited grassroots surveys. The decrease in activity relates mainly to difficulties encountered in raising exploration funds; there is no shortage of good targets yet to be tested. Results of much of the stratigraphic drilling done in 2000 increased the potential of some properties by providing valuable new data on which to vector a search for this elusive target.

In the Findlay block of Aldridge Formation rocks, located southwest of Canal Flats and between Findlay and Skookumchuck creeks, Eagle Plains Resources Ltd. has extensive claim holdings. In 1999, all were optioned to three major companies in three contiguous properties, and all were explored aggressively. In early 2000, Billiton Metals Canada Ltd. decided not to continue with its option on the **North Findlay** group, the northernmost of the three properties, and no further work was done. Rio Algom Exploration Inc. drilled three long holes on the **South Findlay** option (Photo 1), all of which targeted the Lower-Middle Aldridge contact (LMC), which is the stratigraphic position of the Sullivan orebody, as it had been delineated by mapping carried out during 1999. All three holes intersected the LMC and terminated in Lower Aldridge stratigraphy. Laminated greywackes immediately beneath the LMC, which are similar to the thin bedded "Sullivan facies" mudstones at the Sullivan mine, were weakly anomalous in zinc and lead. Nevertheless, based on these results, Rio Algom notified Eagle Plains that it is terminating the option. On the **Greenland Creek** property, the southernmost of the Eagle Plains holdings, Kennecott Canada Exploration Inc. intended to drill at least one long hole to test a strong zinc-in-soil anomaly believed to be underlain by Lower Aldridge rocks close to the LMC. The hole intersected a gabbro sill from 90 to 209 metres, then entered granitic pegmatite which persisted to a depth of 295 metres, at which point the hole was terminated. Kennecott has cancelled its option agreement. Eagle Plains is now seeking new partners for its claim holdings in the Findlay block.

Photo 1. Drilling at South Findlay Project.

Rio Algom Exploration Inc. also completed modest drill programs on two adjoining properties located just 5 to 15 kilometres west of the Sullivan mine in the Matthew Creek area. On the **Pyramid Peak** property, optioned from Abitibi Mining Corp., two holes were drilled to test the Lower-Middle Aldridge horizon. Sullivan-style mudstones were reported in both holes, including a section of laminated wackes containing considerable disseminated pyrrhotite in the second hole, but it has not been reported whether the LMC was actually identified in either hole. Immediately east of the Pyramid Peak property, and closer to Sullivan, Rio Algom completed one drill hole about 600 metres long at the **Bootleg** property which is optioned from Eagle Plains Resources Ltd. Although results of the drilling have not been reported, Rio Algom has notified Eagle Plains that it is terminating the option.

Chapleau Resources Ltd. extended one old drill hole by an additional 292 metres on the **Pakk** property, which the company optioned from Super Group Holdings Ltd. The property is located south of St. Mary Lake and about 25 kilometres southwest of the Sullivan mine. The original hole was drilled by Cominco Ltd. several years ago but a recent reinterpretation of the stratigraphy suggested that it had stopped short of the targeted Sullivan horizon (LMC). Drill results have not been reported and the company carried out little further work that targeted sedex mineralization. Nevertheless, the Pakk prop-

erty is large and is still considered to be one of the highlight prospects in the Purcells for discovery of a Sullivan type deposit. The geology of the property is complex but mapping and drilling have shown that the Sullivan horizon occurs extensively at shallow depth on the property. In 1999, three new showings of massive sulphide mineralization were found by prospecting, one of them being adjacent to a large and very strong zinc-arsenic soil anomaly. All three of these new zones were tested by limited drilling late in 1999 and all gave encouraging results. However, in 2000, after extending the one hole as described above, the company re-directed its work on the property to an investigation of potentially significant quantities of beryllium and other industrial commodities within the Hellroaring Creek Stock (see a later section on industrial minerals activity). The **Pit** property, which adjoins the Pakk on the east, was optioned from Black Bull Resources Inc. Chapleau drilled five holes that targeted sedex mineralization but no results have been released.

Three small projects, each involving only one drill hole, were conducted in the area west and south of Moyie Lake. In January, Chapleau Resources Ltd. drilled a 940 metre hole on the Gas claims just south of the Moyie River. The **Gas** claims were optioned from Abitibi Mining Corp. but are being explored as part of Chapleau's more extensive **Cruz** project. The objective was to test the Sullivan horizon beneath an eight kilometre long north-trending belt of Sullivan - type alteration and vent features. The Sullivan facies was identified and found to be 53 metres thick; it contains abundant iron sulphides and is weakly anomalous in zinc. Abitibi Mining Corp. drilled a single hole on the **Canam** property, which is optioned from Cominco Ltd. and located east of Yahk, adjacent to the United States border. West of Moyie Lake, National Gold Corp. drilled one hole on the **McNeil Creek** property which is under option from Sedex Mining Corp.

OTHER METAL PROJECTS

Redhawk Resources Inc., in a joint venture with ZincOx Resources plc of London, England, is exploring the zinc oxide potential of the past-producing, carbonate-hosted Reeves MacDonald and Annex mine properties. This joint venture is referred to as the **Remac** project. The property straddles the Pend D'Oreille River west of the Nelway border crossing, and is about 35 kilometres southeast of the Trail smelter. Sulphide ore, grading 10% to 15% combined lead and zinc was produced from the mines between 1949 and 1971, but the extensive, overlying zinc oxide capping was not mined due to the lack of extraction technology at that time. The zinc oxide deposits contain zinc grades comparable to those of the primary sulphide deposits. They occur intermittently in a belt at least 3 kilometres in length and locally extend to a depth of up to 450 metres. The companies conducted a trenching and 2600-metre reverse-circulation drilling program to confirm the structural continuity and overall zinc grades of the oxidized zones (Photo 2). Among the better drill intersections were 15.43% Zn and 1.55% Pb over 5.3 metres, and 8.68% Zn and 4.27% Pb over 12.2 metres. Overall, results of the 2000 program were very encouraging, and more aggressive drilling is proposed for 2001. In addition, metallurgical testing is planned to demonstrate that zinc metal can be economically recovered from the oxides using new recovery technology developed by ZincOx. The companies also completed a large trenching program on the **Oxide** property which is north of Salmo on the ridge between Porcupine and Oscar creeks. This property, optioned from Indo Metals Ltd. with an underlying option from Cominco Ltd., contains high zinc and lead values in a deeply oxidized shear zone. The zone is up to 23 metres wide and traceable on strike for at least one kilometre. Unfortunately, assay results from the 2000 trenching program were disappointing and the option agreement with Indo Metals has been cancelled.

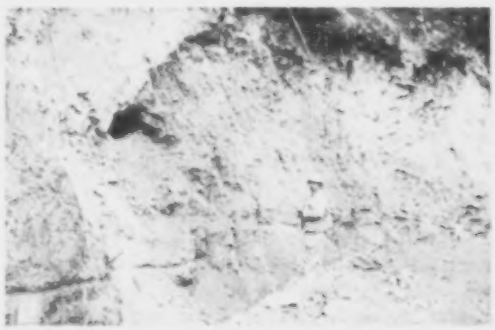


Photo 2. Trench sampling of zinc oxide zone, Remac Project.

South of Nelson, Sultan Minerals Inc. conducted geological and structural mapping, geochemical and induced polarization surveys, followed by excavator trenching on its optioned **Kena** gold-copper property (Photo 3). The exploration program also included logging, splitting and assaying of approximately 1300 metres of diamond drill core from the Kena Gold zone which had been left unsampled by previ-

ous operators. On the recently identified Gold Mountain zone, the company reported that three trenches contained a weighted average grade of 1.65 g/t Au over their combined length of 125 metres. The zone is underlain by the Silver King porphyry, which has a higher background gold level than that of the surrounding volcanic rocks. An I.P. survey over the zone defined a chargeability anomaly 1.8 kilometres in strike length and up to 400 metres wide. The results suggest that gold-bearing sulphide mineralization is present in both the Silver King porphyry and the adjacent Rossland Group volcanic rocks. The company believes that there is potential for a significant bulk-tonnage gold deposit on the property.

Photo 3. Trenching of Gold Mountain Zone, Kena Project.

Also south of Nelson, another Lang Group company, Emgold Mining Corp., completed a preliminary two-hole drilling program on its optioned **Rozan** gold prospect at Red Mountain. A large area of greater than 100 ppb gold in soils contains outcrops of both high grade single quartz veins and lower grade sheeted or stockwork quartz veining. One of the holes was drilled to test the down dip extent of sheeted vein mineralization exposed in surface outcrops. The best intersection in that hole assayed 1.45 g/t gold over 4.1 metres. The second hole targeted a high grade vein exposed on surface and in nearby old underground workings. The vein was intersected and assayed 60.73 g/t gold over 0.25 metres. The company is satisfied that the property has many important characteristics of classic "intrusion-related" gold deposits such as Fort Knox and Pogo, including a gold-bismuth-tungsten-molybdenum geochemical signature. The east boundary of the Rozan property adjoins the Kena property being explored by sister company Sultan Minerals.

In 1999, Bruce Doyle of Nelson, while prospecting on his **McPhee** claims east of Castlegar with funding from a Ministry of Energy and Mines Prospector's Assistance grant, discovered abundant gold-bearing quartz stockworks and veins in an area of widespread gold-in-soil anomalies over weakly altered and fractured granitic rocks. The property was optioned by Cassidy Gold Corp. which, in 2000, undertook a program of further prospecting, mapping, soil sampling, and trenching, then drilled five short holes. In the course of that work, the company rediscovered the old Maud S gold-silver mine which had extensive surface and underground workings on a series of parallel, shallow-dipping quartz veins. Chip sampling of individual veins exposed underground and in pits returned consistently moderate to high gold values, including 68.58 g/t Au over 0.10 metres and 6.07 g/t Au over 0.30 metres. Three holes were drilled in the vicinity of the original vein discovery and two at the Maud S mine. Results were inconclusive due to major disruptions of the mineralized structures by faulting and lamprophyre dikes.

Late in 2000, while funded by another Prospector's Assistance grant, Bruce Doyle discovered and staked a stratabound showing of silver-zinc-lead-copper bearing massive sulphides on a new logging road at Rover Creek southwest of Nelson. A grab sample from the showing assayed 24.59% Zn, 22.35% Pb and 556.4 g/t Ag. The showing occurs within a broad area of abundant mineralized float, and soils are anomalous in several metals, including barium. The property, called **Silver Lynx**, has also been optioned by Cassidy Gold Corp. which plans to conduct a geophysical survey of the anomalous area early in 2001. The mineral deposit type is uncertain due to limited outcrop exposure, but the host rocks appear to consist of metasedimentary and metavolcanic lithologies that are locally well brecciated, siliceous and/or baritic. The initial impression is that this is a volcanogenic massive sulphide occurrence in metamorphosed Ymir Group rocks.

Southeast of Canal Flats, the **Coyote Creek** property of Eagle Plains Resources Ltd. covers the high ground between Coyote Creek and Lussier River. Regional Geochemical Survey data released by the provincial government in 1991 showed the area to be highly anomalous in zinc, as well as nickel, molybdenum and vanadium. Zinc values in sediment samples from streams draining the property area ranged from 380 ppm to 5500 ppm. Geological mapping and detailed geochemical surveys by previous property owners, and by Eagle Plains in 1999, delineated a package of flat-lying, metal-rich Devonian black shales. In year 2000, Eagle Plains transected the stratigraphy of the black shales with two

short, vertical drill holes (Photo 4). Although the black shales were found to be uniformly anomalous in zinc, silver, molybdenum and nickel over a stratigraphic thickness of close to 90 metres, no concentrations approaching ore grade were encountered. More work is planned, however, to explore other parts of this large claim group. The claims also cover gypsum occurrences at lower elevations in the Burnais Formation which stratigraphically underlies the shales, and the company plans to investigate that potential resource. Gypsum is a major industrial mineral commodity throughout the Lussier River valley and is currently being mined by Georgia Pacific Canada Inc. at its Four J quarry which is located north of the Coyote Creek property.

Photo 4. Drilling at Coyote Creek Property.

In the northern Purcell Mountains south of Golden, MineQuest Exploration Associates Ltd. drilled five holes, totaling about 1000 metres, as part of its ongoing exploration of the past-producing **Ruth Vermont** mine and the surrounding Vowell Creek claims. The property is owned by Bright Star Metals Inc. and is believed to have significant potential for additional sedex and/or shear vein-hosted silver-lead-zinc mineralization. The Ruth Vermont mine is reported to have produced more than 17 million grams of silver, 3 million kilograms of lead and close to 6 million kilograms of zinc, with some gold, copper, and cadmium, from 163 339 tonnes that were mined prior to 1981. It is hosted in Horsethief Creek Group sedimentary rocks of the Precambrian Windermere Supergroup.

At the past-producing **Bull River** copper-silver mine, east of Cranbrook, Gallowai Metal Mining Corporation and Bull River Mineral Corporation Ltd. continued their ongoing program of exploration drilling and underground development and sampling. The mineralization occurs in several, steeply-dipping, parallel, multi-stage quartz-carbonate vein systems, that are hosted within major shear structures that cut Middle Aldridge turbidites. For many years, the companies have been exploring the property primarily as a gold prospect, but in early 2000 they published new analyses of samples from the underground workings which indicated high platinum and palladium values in addition to the high gold values previously reported. However, independent analyses of samples collected from sulphide-rich veins both in drill core and underground workings by geologists from the British Columbia Ministry of Energy and Mines, did not confirm the high levels of gold and platinum reported by the companies.

INDUSTRIAL MINERALS

The **Pakk** project of Chapleau Resources Ltd., located south of St. Mary Lake, was optioned from Super Group Holdings Ltd. In the middle of the 2000 field season, Chapleau optioned an additional block of claims that adjoins the east boundary of the pre-existing Pakk property. These new claims overly the Precambrian-age Hellroaring Creek pegmatite stock and Chapleau incorporated them into the Pakk project. At that point, the company redirected its primary focus of activity, temporarily at least, from Sullivan-style sedex mineralization (see earlier section) to an assessment of the pegmatite intrusion for economically significant quantities of beryllium, rubidium, tantalum, rare earths and other industrial commodities. Demand is currently high for these commodities and market prices are escalating. In the past, parts of the Hellroaring Creek stock had been explored as a potential source of beryllium and of feldspar. Prospectors working for Super Group, however, discovered numerous large beryl crystals in areas with no previous history of beryllium exploration. The stock is leucocratic, multiphase, and pegmatitic; it is about 3.5 kilometres long and 1.5 kilometres wide. The pegmatite consists dominantly of quartz, perthite and muscovite with abundant black tourmaline. Analyses of outcrop grab samples and of drill core samples acquired from areas explored in the past indicate that the stock and associated, nearby pegmatite dikes contain potentially significant concentrations of beryllium (forty-six grab samples averaged 3289 ppm), rubidium, niobium, tantalum, cesium and tin. In October, the company drilled a total of eight holes in several of the newly discovered beryl-rich areas and presently is analyzing all of the core for the various target commodities. However, much of the future work will also be to evaluate their recoverability. Chapleau also optioned the **Peg** claims from prospectors Peter Klewchuk and

Craig Kennedy. These are located near Matthew Creek on the north side of the St. Mary River valley. The claims cover three separate beryl-rich pegmatite bodies that have very similar mineralogy, and are believed to be cogenetic with the Hellroaring Creek stock. The pegmatites were originally staked and prospected by Peter Klewchuk as part of his year 2000 Prospector's Assistance grant program. Chapleau Resources has signed a joint venture agreement with Naneco Minerals Ltd. for continued exploration of all of its pegmatite prospects and intend to drill test those on the Peg claims early in 2001.

On **Jubilee Mountain** west of Spillimacheen, W.W.C. Consulting Ltd., an exploration subsidiary of Hydrotech Dynamics Ltd., continued to evaluate its optioned vein barite prospect. In 1999, the company drove two short exploration adits and shipped a few thousand tonnes of barite ore to a mill, which is owned by its parent company, at the Elkhorn barite property on Madias Creek south of Windermere. No further mining was done in 2000 but an aggressive program of surface diamond drilling tested several other veins and breccia zones on the property. A jig concentrator is being constructed at the mine site. This will enable the company to pre-concentrate the ore prior to transporting it to the mill, thereby substantially reducing trucking costs. Further underground development and bulk sampling are planned for 2001. The company also drilled a small number of short exploration holes at the **Elkhorn Barite** property.

During 2000, Westroc Inc. completed a modest drilling program to further define its gypsum resource on the **Kootenay West/East** property which straddles the Kootenay River northeast of Canal Flats. As early as 2005, the company is expected to transfer its production operations to the Kootenay River property from its present operating Elkhorn quarries on Windermere Creek.

Anglo Swiss Resources Inc. entered into a joint venture arrangement with Hampton Court Resources Inc. to continue work at its **Blu Starr** gemstone property in the Slocan Valley. The property contains numerous occurrences of star sapphires, corundum, iolite and garnet. The gemstones occur mainly in syenitic phases of the Valhalla Gneissic Complex and in feldspathic pegmatites that intrude the gneisses. In 2000, the joint venture completed additional prospecting and mapping, as well as sampling and testing of alluvial gravels on its coincident mineral and placer claims.

Crystal Graphite Corp., formerly I.M.P. Industrial Mineral Park Mining Corp. announced plans to develop its **Black Crystal** flake graphite property on Hoder Creek west of Slocan. The graphite is disseminated as loosely-bonded flakes in marbles and associated paragneisses within the Valhalla Gneissic Complex. Late in the year, the company extracted and transported the remainder of a previously permitted 10 000 tonne bulk sample to its partially completed mill near the junction of Koch Creek and Little Slocan River. It also carried out an 1181-metre exploration drilling program to better define the size and average grade of the graphite resource.

Kootenay Diamond Mines Inc. conducted a major heavy mineral sampling and testing program at its **Mark** lamproite-hosted diamond prospect in the Valenciennes River area north of Golden. Very late in the year, Skeena Resources Ltd. started preparing access trails and drill sites for a pending small scale drill test of kimberlite pipes and dikes on its **Ice** diamond prospect, optioned from Standard Mining Corp. (formerly Quest International Resources Corp.), in the Crossing Creek area near Elkford. Sampling by Quest in the early 1990's revealed that at least two of the kimberlite bodies contain isolated fragments of gem-quality macrodiamonds.

Rocky Mountain Tufa Ltd. continues to extract tufa from its extensive surficial deposit at Brisco and to market it at a considerable profit to alpine gardening and landscaping suppliers throughout North America. Several other occurrences of tufa and of travertine scattered along the west flank of the Rocky Mountains have been staked and are being tested by local prospectors.

The insulation and mineral wool manufacturing plant in **Grand Forks**, which has become an important employer in the Boundary area, was acquired by Rockwool International A/S from the original operator, Enertek. It is now operated by Roxul (West) Inc., a subsidiary company. Testing of potential new raw material sources is underway at several sites in the area. Pacific Abrasives and Supply Inc. is processing smelter slag from the Grand Forks dumps, mainly to produce materials for sandblasting at major shipyards and for roofing granules.

A small bulk sample of wollastonite was recovered from the **Rossland Wollastonite** property north of Rossland, and delivered to Cominco Ltd.'s smelter at Trail to be evaluated as a potential natural flux.

COAL

There was no significant regional exploration activity for coal, apart from reverse circulation drilling at or in the immediate vicinity of the five producing coal mines in the Elk Valley. However, the amount of this on-property exploration work, as measured by expenditures and total drilling, increased significantly in response to new market contracts, plans for increased production and a general feeling of optimism at all of the mines. Total drilling amounted to 48 302 metres, up from 36 243 metres in 1999, and the total of exploration expenditures by the five mines was approximately $1.9 million, up from $1.6 million in 1999.

Fording Coal Ltd. completed 6750 metres of drilling at its **Fording River** mine. This included four deep holes on the northwest side of Turnbull Mountain close to but outside of the present area of mining, which is concentrated in the Eagle Mountain and Henretta pits. Fording also completed 4237 metres of reverse circulation drilling at its **Greenhills** mine and 5165 metres at its **Coal Mountain** mine. At the **Elkview** mine, Elkview Coal Corp. drilled 7150 metres and Luscar Ltd. completed approximately 25 000 metres at the **Line Creek** mine.

PRODUCING MINES AND QUARRIES

Locations and names of the important mines and quarries which were in production for all or part of year 2000 in the Kootenay Region are shown on Figure 5. More details are provided in Table 2.

COAL

All five of the coal mines in the Elk Valley maintained steady production through 2000, with only routine seasonal shutdowns. New market contracts have been signed or are being developed, and all of the mines are projecting increased production levels in 2001. **Elkview** Coal, for example, has forecast a production increase from 4.1 million tonnes in 2000 to 5.2 million tonnes in 2001 (Photo 5). Mine-by-mine production for 2000 expressed as millions of tonnes of clean coal are as follows:

Fording River	9.1
Line Creek	2.5
Coal Mountain	2.25
Greenhills	4.3
Elkview	4.1

Photo 5. Elkview Coal.

METALS

The **Sullivan** zinc-lead-silver mine at Kimberley, operated by Cominco Ltd., is the only producing metal mine in the Kootenay Region. Cominco has now confirmed that the Sullivan mine will have exhausted its reserves and will close permanently at the end of December, 2001. The rate of production, about 2 million tonnes per year, is expected to be maintained through its final year. The mine has been in operation for almost a century and, since 1923 when the Sullivan concentrator started treating ore, approximately 150 million tonnes of ore grading 6.2% Pb and 5.6% Zn have been processed. At today's metal prices, production to the end of 2000 represents a total value of about $19 billion.

INDUSTRIAL MINERALS

All the major industrial mineral producers operating at the end of 1999 maintained production at roughly the same rate through the year 2000. Their locations are shown on Figure 5.

Westroc Inc. produced approximately 500 000 tonnes of gypsum from its **Elkhorn** quarries near Windermere. As stated in an earlier section, reserves are expected to last until at least 2005, at which time the operation will be moved to its Kootenay River property northeast of Canal Flats. Gypsum is also being produced intermittently by Georgia Pacific Canada Inc. from its **Four J** quarry on the Lussier River and shipped from the company's rail-loading facility at Canal Flats.

Baymag Mines Company Ltd. continues to ship about 200 000 tonnes of magnesite annually from its mine at **Mount Brussilof** to its processing plant at Exshaw, Alberta, where it is converted to various forms of sintered, calcined and fused magnesia. The

Table 2. Producing Mines and Quarries - 2000.

MINE	OPERATOR	PRODUCTS	PRODUCTION
Fording River	Fording Coal Ltd.	Coal	9.1 million tonnes
Greenhills	Fording Coal Ltd.	Coal	4.3 million tonnes
Line Creek	Luscar Ltd.	Coal	2.5 million tonnes
Elkview	Elkview Coal Corp.	Coal	4.1 million tonnes
Coal Mountain	Fording Coal Ltd.	Coal	2.25 million tonnes
Sullivan	Cominco Ltd.	Zn/Pb/Ag	~2 million tonnes
Moberly	Highwood Resources Ltd.	Silica	~120,000 tonnes
Rocky Mtn.Tufa	Alan Wolfenden	Tufa	~1000 tonnes
Mount Brussilof	Baymag Mines Co. Ltd.	Magnesite	~200,000 tonnes
Elkhorn	Westroc Inc	Gypsum	~500,000 tonnes
Four J	Georgia Pacific Canada Inc	Gypsum	
Crawford Bay	IMASCO Minerals Inc.	Dolomite	
Sirdar	IMASCO Minerals Inc	Crushed Granite	
Kootenay Stone	Kootenay Stone Centre	Flagstone	
Lime Creek	IMASCO Minerals Inc.	Limestone	
Albrit Quarries	Albrit Minerals Corp.	Dolomite, Quartzite	
Rock Creek	Mighty White Dolomite Ltd.	Dolomite	
Beaverdell	Quarry Pacific Ltd.	Dimension Stone (Granite)	

Silica Division of Highwood Resources Ltd. produces approximately 120 000 tonnes of high-grade silica annually at **Moberly**, near Golden, for shipment to various markets.

IMASCO Minerals Inc. processes and ships a variety of specialized industrial mineral products from its plant at **Sirdar**, north of Creston. Raw materials include dolomite and limestone both from its underground mine at **Crawford Bay** and from its small **Lime Creek** quarry on Lost Creek south of Salmo. The company also produces crushed granite and quartzite products from material mined at Sirdar and near Crawford Bay.

Mighty White Dolomite Ltd. quarries and processes dolomite at **Rock Creek**. **Kootenay Stone Centre**, near Salmo, and a few other operators in the same area, produce quartzite flagstone in a variety of colours and patterns from several small quarries, mainly on Porcupine Creek. Granite dimension stone is intermittently mined from two quarries south of **Beaverdell**; the larger one is operated by Quarry Pacific Industries Ltd.

ACKNOWLEDGEMENTS

Thanks are due to the many industry managers, geologists, and other field staff who were willing to share their data and observations, and to provide access to their exploration properties and mines.

Much of the information relating to coal and to industrial minerals in this report were acquired and shared by Barry Ryan and George Simandl, respectively, of the Geological Survey Branch. The author also thanks Dave Grieve of our regional office staff who prepared the location maps for this report.

The quality of this report was significantly improved by editorial comments from W.J. (Bill) McMillan, and, last but not least, thanks are due to Dorthe Jakobsen of the Nanaimo Regional Office, for compiling the total volume and preparing it for publication.

PART B

COALBED METHANE

MOUNT FLEET ALKALINE COMPLEX

PROSPECTORS ASSISTANCE PROGRAM

AN INTRODUCTION TO COALBED METHANE POTENTIAL IN BRITISH COLUMBIA

Barry Ryan
Geological Survey Branch, Victoria

INTRODUCTION

Recently, there has been much interest in coalbed methane (CBM) potential from coal seams. Background information about CBM will be presented, then a brief description of the potential CBM resource of the province and information about CBM exploration activity to date.

The geological process that forms coal also generates a major amount of volatile matter. In fact production of a tonne of anthracite generates over 200 cubic metres of methane (CH_4). Most of this gas escapes into the surrounding rocks but some is retained in the coal as coalbed methane (CBM). Methane is held in coal in three ways:

adsorbed onto the surfaces of microscopic pores where it exists in a quasi liquid state,

as a free gas in the micro porosity in the coal,

in solution in water associated with the coal.

Adsorption is by far the most important way that coal holds methane. Coal is unique among geological strata with regards to its ability to adsorb gases. Adsorbed gas forms a single molecule thick layer coating the surfaces that create the micro porosity in the coal. It therefore has the density of a liquid and this, in conjunction with the very large cumulative surface area of the pores that make up the micro porosity, accounts for the surprisingly large volume of methane that coal can adsorb. In fact a medium rank coal buried at a depth of 500 metres could hold 15 cubic metres of methane per tonne. A conventional natural gas sandstone reservoir holds much less at similar depths (2.5 to 5 m^3). The amount of methane that can be adsorbed by coal is dependent on its rank and depth of burial, which incorporates the effects of temperature and pressure. Coal rank, which is a measure of coal maturity is usually documented by measuring the amount of light reflected back from the vitrinite coal maceral (Rmax%). Sub-bituminous coals have values in the range 0.3% to 0.7% and high rank anthracites have values over 2%. The amount of ash included in the coal also affects the amount of CBM; ash does not adsorb CBM.

Wholesale natural gas prices per mcf (1000 cubic feet) rose from about 2.2 SUS in 1998 to about 5.3 SUS in 2001. At the same time the Canadian dollar has fallen from 0.68¢US in 1998 to 0.65¢US in 2001. These two trends have stimulated interest in exploration for additional supplies of natural gas, which is composed mainly of methane (CH_4). Areas of interest include the offshore, Mackenzie delta and north shore Alaska for natural gas, and coalfields for coalbed methane (CBM). This note addresses the interest in CBM in British Columbia and gives an overview of the potential resource in the province.

Interest in CBM in B.C. has risen steadily over the last few years. In the last 2 years CBM exploration rights in southeast and northeast B.C. have been sold for about 20 million dollars. In the last year Alberta Energy Corporation has permitted 13 test wells in the Elk Valley coalfield and to date has drilled six. In the northeast BP has plans to begin drilling 4 wells in the spring 2001. Other companies have expressed interest in drilling test holes in northeast B.C. and other parts of the province.

British Columbia has a measured coal resource of over 3 billion tonnes. This is really an estimate of coal available for surface and underground mining. Therefore to some extent it is an estimate of the coal resource that is not favorable for CBM exploration because it is too shallow. The estimated coal resource to a depth of 2000 metres, which is available for CBM exploration is in the range of 250 billion tonnes.

SUMMARY OF CBM RESOURCE POTENTIAL IN B.C.

Coal in B.C. occurs in a number of different geological environments. Each has different implications for CBM development.

About 80% of the coal resource in the province is contained in a number of upper Jurassic to lower Cretaceous coalfields in the foothills of the Rocky

Mountains. These coalfields are within fold and thrust belts and are defined by continuous outcrop or subcrop of coal bearing formations. In the south are the Flathead, Crowsnest, Elk Valley coalfields (Figure 1) and in the north the Peace River coalfield. The Bowser Basin in northwestern B.C. is also in a fold and thrust belt. Other Cretaceous coalfields, such as those on Vancouver Island and at Telkwa, are less deformed and the main structures are vertical faults of various ages. There are also some significant Tertiary deposits in the province, the largest being Hat Creek. Generally these deposits are fault bounded and internally faulted but folding is minimal. Coal rank is generally low and their CBM potential depends in part on the presence or absence of biogenic methane.

In some coalfields, the coal-bearing formations form basins, therefore the traditional limits of the coalfield define the area underlain by coal, hence the area with CBM potential. In other coalfields the coal bearing formations dip to increasing depths and historical limits of the coalfield include only areas where surface mineable coal may exist. In these cases the traditional coalfield limits do not outline the area of CBM potential.

Published CBM resource assessments for southeast British Columbia indicate potential for more than 19 Tcf (540 billion cubic metres, Johnson and Smith, 1991) and for northwest British Columbia 8 Tcf (230 billion cubic metres, Ryan and Dawson, 1993). The author estimates a resource of over 60 Tcf (1700 billion cubic metres) for northeast B.C. and on Vancouver Island the resource is estimated to be 0.3 to 1.6 Tcf (14 - 42 billion cubic metres). To put these numbers in perspective, at present, about 0.8 Tcf (22 billion cubic metres) of natural gas are produced in British Columbia each year.

A large CBM resource does not necessarily mean there will be a large reserve. A number of practical constraints must be met. The methane content per tonne must be high enough to permit easy extraction, that is the coal seam should be close to saturated with CH_4 based on depth and rank so that pressure will not have to be reduced to much before gas desorption starts, and regional permeability must allow extraction of sufficient reserve to make a single well economic.

Permeability is of overriding importance for a CBM exploration program to succeed. Permeability in coal seams is largely dependent on cleats, which are tensional fractures characteristic of coal. Consequently they probably (but not exclusively) form when the coal is at relatively shallow depth, either during burial or during uplift.

In British Columbia where many of the coal basins have experienced varying degrees of deformation, it is important to consider the stress time history of a coal seam in conjunction with its time *versus* maturation history. In some areas early onset of deformation hindered formation of cleats or destroyed existing ones by shearing.

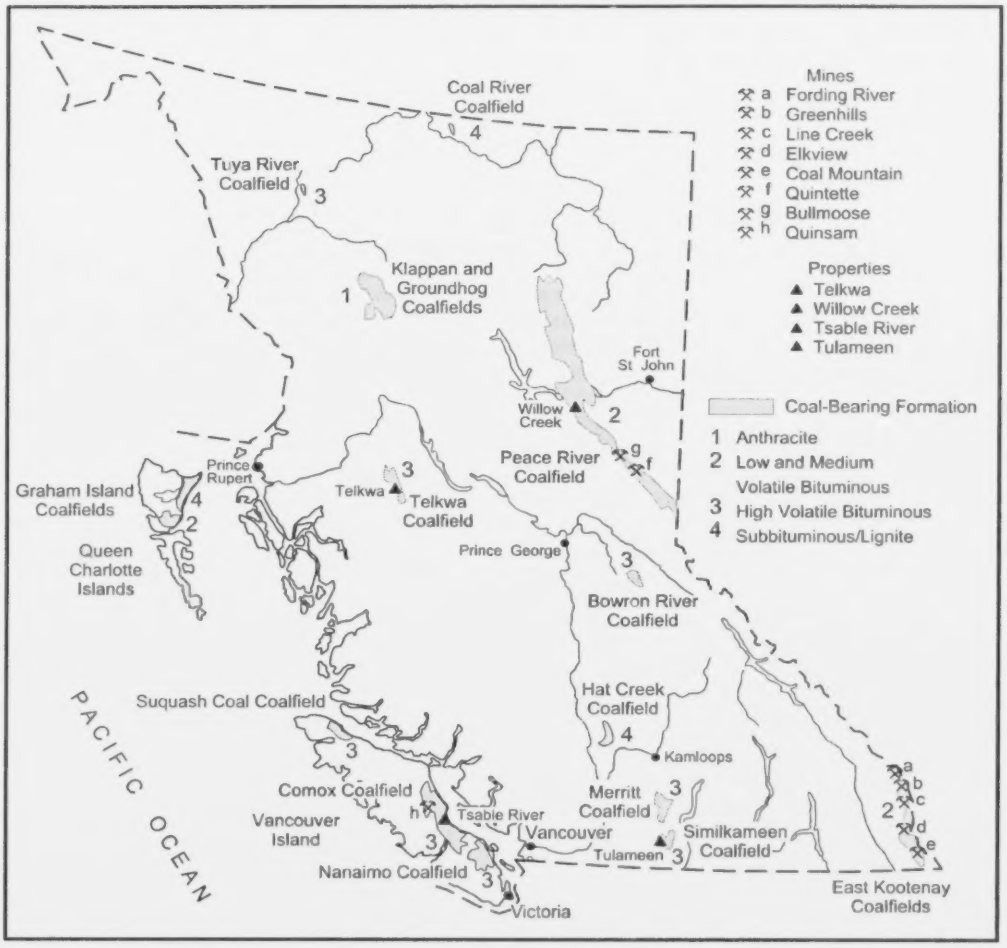
Methane formed during coalification is referred to as thermogenic. However, bacteria also can generate biogenic CH_4 from coal under the right conditions. Carbon isotopes indicate that biogenic methane in coal seams is much more important than originally thought (Scott, 1995). Generation of biogenic methane requires consortia of bacteria that use hydrogen and CO_2 to produce methane. Depending on conditions, more or less CO_2 can remain in the gas (Scott, 1995). Biogenic methane generation is usually initiated when meteoric waters penetrate coal seams and introduce bacteria into this anaerobic environment. The bacteria are active on the surface of cleats.

PEACE RIVER COALFIELD

The Peace River coalfield contains a number of coal bearing units that regionally dip to the east into the western Canadian Sedimentary Basin. In order of decreasing age these are the Minnes Group, Gething Formation and Gates Formation. Younger formations also contain thin seams but are unlikely to be economic for CBM production. Upper Cretaceous and Tertiary formations with sufficient coal for CBM exploration outcrop in Alberta.

The coal resource in the Peace River coalfield to a depth of 2000 metres is estimated to be more than 160 billion tonnes. This is divided between the Gates (+10 billion tonnes) and Gething Formations (+130 billion tonnes). The Gething Formation underlies a large area of the Peace River coalfield though it thins markedly at the south end of the field. The best coal development in the formation is between Williston Lake and Sukunka River to the south. It contains coal at depth to the east towards Dawson Creek. South of Sukunka River the formation is thin and contains only a few seams. Data on coal in the formation there are sparse because it was not extensively explored. The Gates Formation contains coal from the Sukunka River south to the Saxon property near the Alberta border, although thicknesses appear

Figure 1. Coalbed Methane in BC.



Tcf = trillion cubic feet **cm = cubic metres** **bt = billion tonnes** **cm = cubic metres**

Coalbed methane resources are calculated using estimated coal resource, rank and depth data and an appropriate gas content. Very little measured desorption data are available to confirm the gas contents used in the calculations. With the exception of the Kootenay coal fields data, which comes from Johnson and Smith (Petroleum Geology Special paper 1991-1) all other calculations are by Barry Ryan (GSB) and are either from GSB publications or internal studies.

	bt	Tcf		bt	Tcf
Peace River	160	60	Telkwa	0.8	0.13
Kootenay	50	19	Tulameen	0.2	0.05
Bowser Basin	37	8.1	Suquash	0.3	0.045
Hat Creek	2	0.5	Tuya River	0.7	0.04
Comox	3	0.8	Coal River	0.1	0.006
Nanaimo	1	0.3	Bowron River	0.4	0.008

TOTAL POTENTIAL CBM RESOURCE = 90 Tcf OR 2500 X 10^9 cm

NOTE: RECOVERABLE RESERVE WILL BE MUCH LESS THAN THIS ESTIMATE OF POTENTIAL RESOURCE

to thin to the east at depth in the equivalent formation (Falher).

Coal rank varies in both formations. In the Gething, rank is generally medium-volatile bituminous but decreases to the north and northeast toward Williston Lake and in the Burnt River area is low-volatile bituminous. The Gates is mainly medium-volatile bituminous but ranks on the western margin of the coalfield are lower. In both formations rank trends are somewhat complicated probably because of post thrusting coalification.

The CBM potential for the Northeast coalfield is enormous and has variously been calculated to be between 60 and 200 Tcf (1700 to 5664 billion cubic metres). In that there is no CBM production, one can only have moderate confidence in any estimate of the coal and CBM resource potential and should treat all estimates with extreme caution.

There has been some previous CBM exploration in the Peace River coalfield. This falls into 3 categories. First were estimates of desorbed gas contents of samples collected from shallow holes. These data were collected as part of the appraisal of the underground coal mining potential of a number of properties. The data generally indicate low gas contents, but the data are old and were collected at shallow depths; they have little relevance to CBM resource evaluation. Second, adsorption work done on samples from Gates coals (Lamberson and Bustin, 1992) confirmed the high adsorption capacity of Gates Formation samples with varying maceral compositions. Third, there are limited CBM data for the Gething Formation (Dawson *et al.*, 2000). Phillips Petroleum carried out one CBM exploration program (Dawson *et al.*, 2000). In 1995/96 Phillips drilled 4 holes into the Gates Formation in an area 30 kilometres southeast of Tumbler Ridge. The holes intersected cumulative thicknesses of coal averaging 20 metres at depths ranging from 1200 to 1550 metres. Gas contents ranged from 6 to 26 cc/g on an as received basis. Comparisons of desorption and adsorption data indicate that the seams are close to saturated; apparently, low permeabilities were encountered. This is not surprising considering the structure and depth.

SOUTHEAST B.C. COALFIELDS

The southeast corner of British Columbia, often referred to as the East Kootenay region, contains the Elk Valley, Crowsnest and Flathead coalfields. Coal is contained in the Mist Mountain Formation of the Jurassic - Cretaceous Kootenay Group. The formation consists of a sequence of interbedded clastic sediments, ranging from mudstone to conglomerate, and coal. The formation averages 500 to 600 metres in thickness of which 8% to 12% is coal. The total resource in the three fields is estimated to be in excess of 50 billion tonnes.

Coal seams range in rank from low to high-volatile bituminous with the highest rank coals being exposed in parts of the Crowsnest coalfield. Coals at the base of the section in the southwest part of the coalfield have vitrinite reflectances (Rmax%) of over 1.6% (Pearson and Grieve, 1978). Generally coals at the base of the Mist Mountain Formation are medium-volatile while those in the upper part of the formation are high-volatile.

ELK VALLEY COALFIELD

The coal resource to a depth of 1500 metres in the Elk coalfield is estimated to be 19 billion tonnes (Johnson and Smith, 1991) with an estimated CBM resource potential of 7.7 Tcf (218 billion cubic metres).

The Elk Valley coalfield contains 2 north trending synclines separated by a major normal fault. The Bourgeau Thrust defines the west edge of the Elk Valley coalfield. To the east, the east limb of the Greenhills Syncline, which plunges to the south, is cut by the north trending Erickson normal fault, which has down dropped rocks on the west by over 1500 metres. East of the Erickson fault the coalfield is folded into the Alexander Creek syncline, which is cut by the Ewin Pass thrust. In the three mines of the Elk Valley coalfield, coal seams in both synclines tend to be fragmented or sheared. Generally, either cleating is not well developed or has not survived the shearing. Thicker coal seams are developed low in the section but they tend to host major thrusts, consequently most are extensively sheared.

There is a history of CBM exploration in the field. In 1981 CANMET desorbed samples from 3 holes over a depth range of 0 to 400 metres (Feng *et al.*, 1981). They found that seams above 200 metres contained less than 2 cc/g of gas but below 200 metres gas contents ranged from 5 to 11 cc/g.

Fording drilled a single hole into the core of the Greenhills Syncline in 1993. The hole, drilled to 533 metres depth, intersected 44 cumulative metres of coal between 300 to 520 metres depth. Gas contents ranged from about 3cc/g to 12.6 cc/g on an air-dried basis (arb), ash varied from 4% to 60%. Seams ap-

pear to be undersaturated and gas contents do not increase with depth. The apparent degree of undersaturation indicates that a considerable reduction in hydrostatic pressure would be needed to obtain a sustained gas flow. Generally measurements indicated low permeability for the coal seams; they ranged from 1 to 6 mD (Dawson *et al.*, 2000)

Norcen drilled 4 stratigraphic holes in the northern part of the Elk Valley coalfield in 1991 then drilled a limited production test well in 1992. The holes were located on the east Limb of the Alexander Creek syncline. In this area the Mist Mountain Formation is 650 metres thick and contains 19 seams with a cumulative thickness of 54 meters. Gas contents averaged 13.25 cc/g for coals deeper than 250 metres. There were indications of moderate CO_2 contents in the gas desorbed from some samples. Gas contents did not increase systematically with depth and this may in part be because lower seams are rich in inert macerals and therefore have lower gas storage capacities than coals rich in vitrinite macerals.

Suncor drilled a single hole in the core of the Alexander Creek syncline south of the Greenhills coal mine in 1998. Data are not public but the company did not follow up on the exploration.

CROWSNEST COALFIELD

The Crowsnest coalfield has a coal resource of over 25 billion tonnes and a potential CBM resource of 12 Tcf (340 billion cubic metres) (Johnson and Smith, 1991). The field includes the Elkview mine in the north and extends from Sparwood to 20 kilometres south of Fernie. The structure is that of a large basin that is cored by the younger Elk Formation and almost completely rimmed by outcrops of the older Mist Mountain Formation. Coal rank varies around the perimeter and down dip (Pearson and Grieve, 1985).

Three companies drilled stratigraphic holes in the field. Mobil/Chevron drilled 2 holes. One, in Morrissey Creek, penetrated 491 metres of Mist Mountain and intersected 7 major coal zones with a cumulative coal thickness of 54.16 metres. The hole encountered numerous problems because of fines, squeezing and strata instability (Dawson *et al.*, 2000). Dawson *et al* reported that the coal is fragmented or sheared. Gas contents ranged from 1.36 to 16.56 cc/g. Based on comparison of measured gas contents on a dry ash free (daf) basis to adsorption isotherm results samples, samples were saturated to between 25% and 63% of maximum gas capacity. Permeability appeared to be low to moderate.

In 1990, Gulf Canada drilled 2 stratigraphic holes in Coal and Lodgepole creeks. Core was collected for desorption but no other testing was done. One hole (Lodgepole Creek) was drilled to 295 metres; 15 desorption tests indicated very low gas contents (averaging less than 1 cc/g). This may be because the hole was spudded above the valley floor and the effective long-term water table was much lower than the collar. The second hole (Morrissey Creek) was drilled to 600 metres and intersected a cumulative coal thickness of 24.41 metres. Coal from this hole had an average gas content of 7 cc/g arb, but appeared to be undersaturated.

Saskoil drilled holes close to the location of the 2 Gulf holes. Two holes were near Morrissey Creek and, combined, they intersected about 500 metres of the Mist Mountain Formation with about 63 metres of coal. The coal was moderately gassy with gas contents ranging from 0.4 cc/g to 11.9 cc/g . The third hole was drilled in the Lodgepole Creek area near the Gulf hole and, like the Gulf hole, had very low gas contents. Permeability tests were performed in the holes near Morrissey Creek, results were ambiguous or indicated low permeability.

In most wells the gas content (daf basis) decreased for the lowest seams. This can be explained by changes in petrography because the lower seams are richer in inert macerals, which adsorb less gas. It can also be explained by assuming that all the seams were initially undersaturated and those closer to surface were later recharged with biogenic methane. There are indications that biogenic methane is present in the Elk Valley coalfield.

FLATHEAD COALFIELD

Coal in the Flathead coalfield occurs in a number of outliers of the Mist Mountain Formation, the largest of which is Sage Creek near the United States border. Other smaller ones are Lillyburt, Harvey Creek and Cabin Creek. The coal resource available for CBM exploration is about 1 billion tonnes (Johnson and Smith, 1991) with a potential CBM resource of 0.4 Tcf (11 billion cubic metres).

BOWSER BASIN

INTRODUCTION

The Bowser Basin is a remote region of rugged mountainous terrain in northern British Columbia. The area encompasses approximately 50 000 square kilometres and is bounded on the east by the Omineca and Cassiar mountains and on the west by the Coast Mountains. The Basin is defined by the outcrop extent of the Bowser Lake Group of Middle Jurassic to Lower Cretaceous age. The group contains a thick assemblage of at least 3500 metres of sediments that generally lack good stratigraphic markers or fossils and are moderately to intensely folded. It is a successor basin filled with a regressional sequence of marine to non-marine sediments that were deposited conformably on volcanics of the Hazelton Group. The Stikine Arch borders it to the north and the Skeena Arch to the south.

Coal in the northern part of the Bowser Basin is found in the Jurassic Currier Formation in the Klappan coalfield and in its equivalent in the south the Prudential Formation in the Groundhog coalfield. The Currier Formation crops out on all four sides of the Mt. Biernes Synclinorium, the most prominent regional structure in the coalfield. Potentially economic coal seams up to 7 metres thick are present in the lower third of the Currier Formation. In the Mt Klappan area the formation is 900 to 950 metres thick and contains a cumulative coal thickness that ranges up to 53.62 metres. At Panorama Mountain to the south the stratigraphically equivalent interval of coal-bearing strata exceeds 1300 metres and contains up to twelve coal zones with a cumulative thickness of 9 metres over an interval of 300 metres.

STRUCTURE

Fold styles in the basin range from open upright chevron to overturned and stacked recumbent. Folds often resemble asymmetric mega-kink bands with shallow and steep dipping limbs. The doubly plunging Mt. Biernes Synclinorium, which trends southwest for 85 kilometres, dominates the area between the Nass and Skeena rivers. The coal-bearing Currier Formation is exposed on its east and west limbs in the Nass and Skeena valleys and wraps around both ends of the trace. The depth to the Currier Formation below the axial trace of the synclinorium is probably between 1000 to 2000 metres. Coal-bearing rocks therefore underlie approximately 2000 square kilometres around the synclinorium. This comprises the area with CBM potential.

COAL RANK

Coal rank ranges from semi-anthracite to meta-anthracite. Reflectance values are higher to the east and lower in the central part of the coalfield. The average Rmax% over an area of 6600 square kilometres is 3.88% but within it there are 2100 square kilometres in which the reflectance is less than 3.5%. Values for the top of the Currier average 2.9 %, and those for the base 4.59%. However, the high value for the base of the Currier Formation is biased by some very high values in the extreme southeast of the area. A coalification gradient for the Currier Formation was calculated as 0.20 % /100 metres.

At high temperatures CBM is either destroyed or expelled from coal. Dow (1977) determined that the preservation limit for dry gas in terms of the rank of coal as defined by reflectance is between 3.0% and 4.0 %. Wolfgang and McMechan (1988) use a dry gas preservation limit defined by a reflectance of 4.8%. Coal that has been heated to this rank has the ability to adsorb methane once the temperature falls but the possibility exists that all the methane has been destroyed or flushed from the rocks. Bustin and Moffat (1989) suggest that the maximum temperature experienced by coal at the base of the Currier Formation was between 180°C and 230°C. CBM resource calculations depend on estimating how much methane the coal retained at the maximum depth of burial and highest temperature reached, and how much was scavenged as the coal was uplifted.

The adsorption versus depth relationship for coal as it is progressively buried and heated indicates an adsorption capacity of 6.8 cm/tonne (245 scf/ton) at the maximum depth of 5000 metres for the coal zone (Ryan and Dawson, 1993). At this depth adsorptive capacities are decreasing as depth and temperature increase. The adsorption capacity initially increases with depth and increasing rank but eventually the influence of temperature predominates and the capacity decreases with increasing depth. This means that at maximum depth of burial, coal higher in the coal zone will have a higher adsorption capacity than coal lower in the coal zone and may be able to scavenge gas from deeper seams. This inversion is maintained until the cover depth is reduced to less than 1000 metres. Isotherms that indicate high gas contents for anthracites are misleading. It is unlikely that one will find a saturated anthracite seam and it becomes important to know the depth, temperature and rank history of the anthracite in order to predict its

adsorption capacity. High rank coals whose maximum depth of burial was greater than their present depth may be undersaturated in methane.

COAL RESOURCE

The total potential coal resource in the Klappan and Groundhog coalfields is 37 billion tonnes and much of this is in the Currier Formation within the Bierncs Synclinorium. This is a speculative number and should be used only as an indication of the order of magnitude of the coal resource available for CBM exploration.

POTENTIAL METHANE RESOURCE

The estimated potential CBM resource of the Groundhog and Klappan coalfields is up to 8 Tcf (or 214 billion cubic metres). The resource assessment is restricted to the area of Currier Formation outcrop within the coalfields. Coal outcrops outside this area but usually in thin and widely scattered seams. The Biernes Synclinorium area of the Groundhog and Klappan coalfields could be a major source of CBM.

Sustut Basin

The upper Cretaceous to Tertiary Sustut Group unconformably overlies the Bowser Lake Group along its eastern margin. although coal is found in strata of the deformed Bowser Lake Group and in the overlying less deformed Sustut Group. the area appears to have limited CBM potential.

VANCOUVER ISLAND COALFIELDS

INTRODUCTION

Coal resources of the coastal area of British Columbia are restricted to Vancouver Island, the Queen Charlotte Islands and some of the Gulf Islands. Coal rank ranges from anthracite to lignite, with most being high-volatile bituminous. Ages range from Jurassic to Tertiary though most is found in the Nanaimo Group, which is of Upper Cretaceous age. The major Upper Cretaceous coalfields on Vancouver Island are the Nanaimo and Comox fields. Smaller coalfields of the same age are the Suquash, Cowichan and Alberni. The Quatsino coalfield on Vancouver Island is Lower Cretaceous. Not much is known about cleat development in Vancouver Island coals but generally they are less deformed than coals in southeast and northeast British Columbia.

There are at least three coal bearing formations within the Nanaimo Group. The first is the basal Comox Formation, which is overlain by marine sediments of the Haslam Formation in the Nanaimo coalfield or the Trent River Formation in the Comox coalfield. The others are in the Extension and Protection formations, and these host the coal seams that provided coal for former mines of the Nanaimo coalfield. This coalfield is centered on the town of Nanaimo and from 1849 to about 1950 over 50 million tonnes of coal were extracted from seams in the Extension and Protection formations. The Comox coalfield is centered on the Town of Comox and includes the Quinsam mine, which is the only operating coal mine on the island. Coal seams in the Comox coalfield are in the Comox Formation. This coalfield is considered to have good CBM potential.

A number of holes were drilled on Vancouver Island specifically to assess CBM potential. Novacorp drilled 14 holes between 1984 and 1985 and British Petroleum drilled two holes in 1986. Gulf and British Petroleum also drilled deep holes in the early 1980's but not specifically for CBM. In 1996 Quinsam Coal Corporation initiated an exploration project in the Tsable River area south of Courtenay. Core was collected from this program and desorbed (Ryan, 1997). In 1994, samples from two holes drilled near the Quinsam coal mine were desorbed (Ryan and Dawson, 1994).

The CBM potential of the Nanaimo coalfield and parts of the Comox coalfield extend eastward under Georgia Strait beyond the surface expression of the fields. Estimates of resource potential for these coalfields may include undersea CBM, which at the moment cannot be legally recovered.

Published estimates of the CBM resource potential for Vancouver Island range from 230 bcf (6.5 million cubic metres) Proudlock (1990) to 1 Tcf (28 million cubic metres) (Energy Market Update, 1992). The first number is not broken down in terms of the different coal basins, gas contents or coal tonnages. Proudlock (1990) used an average gas content of 9cc/g (288 scf/ton) to calculate his value. Estimates of the coal resources on Vancouver Island range from a low of 800 mt to a high of 6920 mt and average 3850 mt.

NANAIMO COALFIELD

Estimates of the size of the Nanaimo coalfield range from 259 square kilometres (McKay, 1947) to 777 square kilometres (Dolmage Campbell and As-

sociates, 1975). Previous independent estimates of coal resource remaining in the Nanaimo coalfield are 60.5 mt (McKay, 1947), 10 mt (Smith, 1989) and between 10 and 70 mt (Dolmage Campbell and Associates, 1975). Coal rank is high-volatile A bituminous. Recent work indicates that there is also coal in the Comox Formation within the Nanaimo coalfield. Coalbed methane opportunities in the Nanaimo coalfield are probably limited because most of the coal in the Pender and Extension formations (Douglas and Wellington seams) has been mined. There may be some potential to retrieve CBM from the underground mine workings, but these often now underlie residential areas of Nanaimo. There may be potential in the deeper Comox Formation. Most of the CBM potential will be in the eastward extension of the Douglas seam and the deeper Comox seam if it is extensive. Generally it becomes uneconomic to extract CBM below about 2000 metres depth because of problems completing drill holes? and decreased permeability.

The Douglas seam subcrop and the outer coastline of the Gulf Islands to the east and the generally defined bounds of the Nanaimo coalfield to the north and south apparently outline the area of Nanaimo group strata that are favorable for CBM exploration. This provides a tract area of 400 square kilometres. Cumulative coal thickness in the Douglas coal zone ranges from 3 to 10 metres (Cathyl-Bickford, 1992). A single intersection of the Comox seam was 3.0 metres thick. The potential CBM resource of the Nanaimo basin is estimated to be in the range of 0.4 Tcf.

COMOX COALFIELD

The Comox coalfield extends from 20 kilometres north of Nanaimo to Campbell River and covers about 1230 square kilometres. The coalfield is subdivided into six sub-basins: Quinsam, Campbell River, Anderson Lake, Cumberland, Tsable River and Qualicum. Generally the rank in all the sub-basins ranges from high-volatile B bituminous to high-volatile A bituminous. There is a tendency for rank to increase to the south (Kenyon and Bickford, 1989). Coal in the Comox coalfield is restricted to the Comox Formation.

Quinsam Sub-Basin

The Quinsam mine is in this sub-basin where two seams occur in the Cumberland Member and two seams in the Dunsmuir Member of the Comox Formation. Away from the mine area information about this sub-basin is sparse. The average Rmax% value is 0.70% +/- 0.07% indicating a rank of high-volatile B bituminous and cumulative coal thickness is about 7.5 metres. Some desorption data (Ryan and Dawson, 1994) were collected from 2 shallow holes near the Quinsam coal mine. Gas content of seven samples collected from depths ranging from 100 to 150 metres ranged from 0.44 cc/g to 1.632 cc/g on a dry ash free (daf) basis. The sub-basin covers an area of 155.4 square kilometres (Dolmage Campbell and Associates, 1975) and is generally fault bounded. The total coal resource in the sub-basin is about 200 mt Dolmage Campbell and Associates (1975). After removing near surface, the tonnage reduces to about 100 mt of coal available for CBM exploration.

The CBM resource associated with the mine, based on an average gas content of 1.6 cc/g is 1.7 Bcf (0.05 billion cubic metres). Kenyon *et. al.* (1991) estimated a resource of 90 Bcf (2.55 billion cubic metres) for the whole field using an average methane content of about 4.7 cc/g. This estimate is high based on present data. Using an area of 155 square kilometres, assuming that a cumulative coal thickness of 7.5 metres (Bickford and Kenyon, 1988) is present over half the field, and that the gas content is 1.6 cc/g, the resource would be 50 Bcf (1.4 billion cubic metres).

Campbell River Sub-Basin

The Campbell River coalfield extends from Campbell River in the north to Oyster River in the south. Nanaimo Group rocks do not extend under Quadra Island so that the approximate extent of coal-bearing rocks is 138 square kilometres. Separate estimates of the resource of the sub-basin range from 74.5 mt to 400 mt. (Dolmage Campbell and Associates, 1975). With an area of 138 square kilometres, if the coal resource is 400 mt, then the average coal thickness through out the whole basin is 2.4 metres. The CBM resource is estimated to be about 40 Bcf.

Anderson Lake Sub-Basin

The Anderson Lake area extends from south of Oyster River to Brown River. Coal resources are estimated to be 21.9 mt. The area of the sub-basin is approximately 450 square kilometres. There is little information on seam thicknesses or quality. Seams range up to 2 metres, are very ashy and were intersected at depths ranging up to 160 metres. A speculative CBM resource potential is 24 Bcf (0. 686 billion cubic metres).

Cumberland Sub-Basin

The Cumberland sub-basin extends from Brown River in the north to south of Cumberland and east of Comox; the approximate area is 266 square kilometres. The area has a possible resource ranging from 228 mt to 240 mt (Dolmage Campbell and Associates, 1975). Four major seams are present with cumulative thickness ranging from 2 to 8 metres. There are some CBM emission data from mines in the area, and average gas contents range from 7.8 to 11.7 cc/g at depths that average 250 metres. Two samples were tested for CBM in the field; one had 4.12 cc/g (132 scf/ton) at 122 metres and the other 2.4 cc/g (77 scf/ton) at 124 metres. The CBM potential is moderate to good considering the number of seams and amount of coal in the section and the CBM resource estimate is 160 Bcf (4.5 billion cubic metres).

Tsable River Sub-Basin

Including Denman Island, the area of this sub-basin is 272 square kilometres. The area is at the southern end of the Comox coalfield and northern end of the Cowichan fold and thrust belt. Reserve estimates range from 148 mt. to 265 mt. (Dolmage Campbell and Associates, 1975). Both these numbers are reserve not total resource estimates. The total resource to 2000 metres could be over 1 billion tonnes. Cumulative coal in the section is about 8.3 metres contained in up to 4 seams. Some CBM has been extracted from holes in the area that are about 500 metres deep (Bickford *et al.*, 1990). Gas has been reported in a few deep holes in the Tsable River area (Cathyl-Bickford, 1991). In 1996 (Ryan, 1997) desorbed a total of 13 samples covering depths from 126 to 376 metres. Gas contents on an as-received basis range from 1.6 to 5.5 cc/g. The gas contents increase consistently with depth but appear to be undersaturated. Based on a linear extrapolation, data indicate that gas contents at 600 and 1000 metres may be 6.2 and 8.4 cc/g for 20% ash coal. These concentrations are high enough to make the area attractive for its potential CBM resource. Resource calculations for part of the southern end of the Comox basin indicate a potential of about 0.45 Tcf (12.6 billion cubic metres). The Tsable River coal has a rank of high-volatile A bituminous based on four Rmax% values that average 0.83%. The area has attractive CBM potential and is well located in terms of markets.

Qualicum Sub-Basin

South of Tsable River in the Qualicum area there is little information on coal distribution. Dolmage Campbell and Associated, (1975) could find no record of coal occurrences south of Tsable River in the Comox Basin and considered the coal potential of the sub-basin to be very low. Bickford and Hoffman (1991) report two coal occurrences with seams that are 3.26 and 1.99 metres thick (including rock splits) at Cowie and Wilfred creeks. The CBM potential for the Qualicum sub-Basin is considered to be low and no estimate is made.

ALBERNI COALFIELD

The coalfield, which contains rocks of the Upper Cretaceous Nanaimo Group, covers about 190 square kilometres in the Alberni valley centered on the town of Alberni. Prospecting over the years has found only a few outcrops of coal. It is unlikely that there is any significant CBM potential.

COWICHAN COALFIELD

The Cowichan coalfield, which includes Upper Cretaceous Nanaimo group rocks, extends from Sidney in the south to Chemainus in the north. The coalfield includes the area around Cowichan Lake and extends to the east to encompass many of the southern gulf islands with the exception of most of Saltspring Island. The CBM potential is very low and no CBM resource is assigned to the Cowichan coalfield.

QUATSINO SOUND COALFIELDS

Nine fault-defined basins of Lower Cretaceous rocks cover a cumulative area of 260 square kilometres in the Quatsino Sound area. The four major basins are Coal Harbour, Quatsino, Winter Harbour and Standby River. Thin coal seams, generally 1 metre or less in thickness, have been explored in a number of places without success. There is little to no CBM potential.

SUQUASH COALFIELD

The basin covers an area of 120 square kilometres. Coal seams in Nanaimo Group strata are of high-volatile B to A bituminous rank (Kenyon, 1991). Beds dip at 5 to 10° to the northeast. The coal bearing section is at least 360 metres thick. Coal is in

the upper 200 metres of the section in approximately 9 zones that contain about 4 metres of coal in total. If the basin is underlain on average by 2 metres of coal then the coal resource would be about 300 mt. If the coal bearing stratigraphy extends to the northeast under Malcolm Island, it provides a basin area of 300 square kilometres and a potentially larger coal resource. Assuming a coal resource of 300 mt the estimated potential CBM resource is 45 Bcf (1.3 billion cubic metres).

QUEEN CHARLOTTE ISLANDS

JURA-CRETACEOUS PROSPECTS

Jura-Cretaceous Queen Charlotte Island coals occur in the Yakoun, Queen Charlotte and Haida formations, all of which are folded and faulted. The CBM potential is low.

TERTIARY COAL

Lignite occurs in the lower member of the Skonun Formation that underlies the northeastern portion of Graham Island. A number of seams of lignite and coal of higher rank have been intersected in oil wells but no reserve calculations exist. Smith (1989) estimated a resource of 50 mt (inferred) whereas McKay (1947) estimated a resource of 739 mt (probable plus possible). Three coal quality analyses indicate a rank of lignite to sub-bituminous. The CBM potential is low and no CBM resource is assigned to the Skonum Point area.

TELKWA

INTRODUCTION

The Telkwa coalfield in central British Columbia extends for about 50 kilometres along the Bulkley River from north of the town of Smithers to south of the village of Telkwa. Two coal bearing units separated by a marine mudstone unit are contained in the Lower Cretaceous Skeena Group. The upper unit (Unit 3) contains at least 8 seams with cumulative coal thickness up to 14 metres. The lower unit (Unit 1) contains a single coal zone with cumulative coal thickness up to 7 metres. South of Telkwa, these two units contain 20 to 50 million *in situ* tonnes which are potentially open pit mineable. In the whole field a coal resource of approximately 850 million tonnes is outlined at varying levels of assurance. Coal rank ranges from high-volatile bituminous A to anthracite, though most of the coal is in the range high-volatile A to medium-volatile bituminous. Rmax% values at the base of unit 3 range from 0.86% to 0.95% and average 0.91% . The Rmax% values for Unit 1 range from 0.86% to 1.1% and average 0.95 %. Rank increases to the south and north away from the centre of the field. In the south, measurements on outcrop coal provide an average Rmax% value of 2.3 % . The coal adjacent to the Bulkley River has an average Rmax% value of 1.27 % and further to the north a sample has an Rmax% value 1.97 %.

During the 1990 exploration program, five samples were collected from 2 rotary drill holes for desorption studies (Ryan and Dawson, 1994). Excluding one sample, gas contents range from 3.75 to 4.49 cc/g on a daf basis and did not increase with increasing depth. The single low desorption value may have been due to a failure in the canister seal. Based on comparison to adsorption isotherm data the coal appears to be saturated.

PERMEABILITY

Much information on the coalfield is contained in coal assessment and Stage 1 and Stage 2 reports submitted to the B.C. government. These reports include geotechnical studies that formed part of mine feasibility studies and they provide information on permeability and joint patterns. Generally Telkwa coals are hard and well cleated. Seams have moderate permeability and regional joints trend northwest or southwest. Permeabilities of coal seams in Unit 3 were measured in three drill holes in the east Goathorne area at depths ranging from 29 to 158 metres. Values do not correlate with depth and range from 0.5 to 50 milliDarcies. These values cover the range from low to excellent for both coal and CBM recovery, considering the depth of the measurements. The permeability of sections of mudstone, siltstone and sandstone interburden varying in thickness from 14 to 27 metres also were measured in the drill holes. At depths of less than 200 metres, permeabilities of interburden rock and coal range from 13 to 35 milliDarcies. Interburden permeability is on average greater than that of the coal.

POTENTIAL CBM RESERVES

The estimated total CBM resource of the Telkwa coalfield is 0.13 Tcf (3.7 billion cubic metres). This is not large when compared to the resources in major coalfields such as the Elk Valley coalfield, which has a resource of 7.7 Tcf (218 billion cubic metres).

On the other hand the Telkwa coalfield is close to the towns of Smithers and Telkwa, which could offer ready markets for small quantities of gas. Unit 3 contains the most coal in the field, but is generally shallow. The deeper unit 1 contains less coal but is 100 to 200 metres below unit 3. There is a trade off between less coal with higher unit gas contents in Unit 1 and more coal with lower gas contents in Unit 3. The Pacific Northern Gas Limited natural gas pipeline crosses the Telkwa coalfield south of Telkwa. This pipeline connects Prince Rupert and Kitimat with pipelines from northeast and southwest B.C. However, the potential resource in the Telkwa coalfield is probably too small for it to be economic to build the infrastructure needed to collect and compress Telkwa gas to put it into the provincial pipeline network. Much of the resource may be contained in thin seams, with low gas contents and at shallow depths.

TERTIARY COAL DEPOSITS

Tertiary sediments survive in many major watersheds in British Columbia. The sediments, which are generally not well consolidated, are poorly exposed and their subcrop extent is arbitrarily delineated by adjacent high ground underlain by pre-Tertiary rocks. Many of these Tertiary basins contain coal, varying in rank from lignite to medium-volatile bituminous and seam thicknesses that vary from a few centimetres to many metres.

TUYA RIVER

The Tuya River Basin is located between the communities of Dease Lake and Telegraph Creek in northwestern British Columbia (Figure 1). The basin is potentially quite large, yet it has escaped detailed study. The simplest interpretation of the basin, based on limited data, is that it has the form of an open, northerly plunging syncline that is complicated by smaller scale faults and folds. Limits of the basin are poorly defined and in places recent volcanic rocks overlie basin rocks; however, it is estimated that it covers approximately 150 square kilometres and contains nearly 700 million tonnes of coal. About 400 million tonnes are within 1600 metres of surface.

A tentative stratigraphic succession has been established. The section contains two units of Eocene age. The lower unit, 200 to 300 metres thick, is composed of mudstones and sandstones in the west and sandstones and chert-pebble conglomerates in the east; it contains a single coal zone. The coal zone is about 100 metres thick and includes from 5 to 30 metres of coal. The upper unit, which is at least 300 metres thick, is composed of volcanic-pebble conglomerate, sandstones, and volcanic rocks.

In outcrop the coal is blocky, well banded and usually clean with well developed cleats. It is often harder than the enclosing poorly consolidated sandstones. Seams vary in thickness up to 20 metres. Mudstone and bentonite bands are common in the seams. The coal is vitrain rich and contains an unusually high percentage of resin; some bands have up to 5 % as blebs ranging up to 5 millimetres in diameter. Analyses indicate a coal rank of subbituminous B to high-volatile bituminous C. Seventeen samples were analyzed for Rmax% values. Samples from Mansfield Creek and Little Tuya River on the west side of the syncline average 0.76% (7 values) and samples from Tuya River on the east side of the syncline average 0.68% (9 values).

A moderate CBM resource of up to 50 Bcf (1.4 billion cubic metres) may exist in the basin (Ryan, 1991). The resource could be larger because biogenic gas is a possibility in coal of this rank. The CBM resource is estimated by multiplying the incremental tonnages from 200 metres to 1600 metres by CBM concentration values derived using the Ryan equation (Ryan, 1992). Predicted CBM concentrations range from 2.99 cc/g at 300 metres to 7.65 cc/g at 1500 metres.

COAL RIVER

Coal River flows south joining the Liard River approximately 150 kilometres east of Watson Lake and 40 kilometres south of the Yukon border (Figure 1). Coal was first reported in the area in 1891 when lignite boulders were found at the mouth of Coal River. The source of the lignite was located by Williams and DeLeen prior to 1944 (Williams, 1944) about 6 miles (10 kilometres) as the crow flies up river from the Alaska Highway. Generally Tertiary outcrops are restricted to the riverbanks and trees, swamp and a burn zone cover the rest of the area. The area around the river is marked by large crescent shaped slumps, presumably where younger sediments have slid on the clay layer, which overlies the coal.

A number of lignite outcrops were found along the river. The main exposure is on the west bank of the river where, for a length of over 100 metres, the hangingwall section of the seam has a shallow ap-

parent dip to the south. The full thickness of the seam was not observed in any of the outcrops and the thickness exposed ranges up to over 8 metres at one outcrop. The lignite is cleated with two sets generally developed. Typically, 3 to 4 metres of lignite are exposed in the outcrops on the west side of the river. On the east side the topography is flatter and there are fewer outcrops. A water well near where the river crosses the Alaska Highway intersected 15 metres of coal at a depth of 15 metres.

Samples of the lignite were analyzed by Williams in 1944 and by Ryan (1996). Rmax% measurements are difficult to make because of the very low rank. In fact the average of five Rmax% measurements is 0.2%, which classifies the material as a peat and not lignite. This is supported by the average volatile matter on a dry ash free basis which is 75%, but is not supported by the heat value or the as-received moisture measurements, both of which are characteristic of a coal with higher rank.

The Tertiary basin has a possible area of about 35 square kilometres. If the lignite seam is on average 5 metres thick then the preliminary resource estimate is about 100 million tonnes of peat/lignite.

The rank is too low for the lignite to have generated thermogenic methane. However based on experience in the Powder River Basin it is possible that the lignite does contain reasonable quantities of biogenic methane. A lignite resource of about 100 mt could contain a CBM resource of about 0.7 Bcf (0.2 billion cubic metres) depending on its ability to retain free gas and adsorb gas.

HAT CREEK

The Hat Creek Basin located 20 kilometres west of Cache Creek contains of two poorly exposed coal deposits (**Figure 1**). The northern, Number 1, deposit covers 3.5 square kilometres and the larger, Number 2, deposit, 3 kilometres to the south, covers 25 square kilometres. The Tertiary section in the area is 1500 metres thick and is divided into 3 units. The lowest Coldwater unit is 375 metres thick and contains no coal. The overlying Hat Creek Formation is about 500 metres thick of which about 65% is coal (Church, 1977). The upper Medicine Creek Formation is 600 metres thick and contains no coal.

The Hat Creek Basin contains an enormous amount of low rank coal concentrated in a small area. The number 1 deposit has been explored as a potential open pit mine. Reserves in this deposit to a depth of 200 metres are over 500 mt of lignite A to sub-bituminous C coal (Rmax% 0.38% to 0.50%, Goodarzi, 1985). The No 1 deposit comprises two south plunging half synclines truncated on the southeast end by northeast trending gravity faults (Graham, 1989). Dips average about 25°.

The No 2 deposit occurs within a graben that is bounded by north trending normal faults. Displacements on the western faults appear to be more than on the eastern faults causing rotation and a resultant 25° western dip in the sediments. The resource of the No 2 deposit to a depth of 460 metres is estimated to be over 2 billion tonnes (Papic *et. al.*, 1977).

The low rank of the coal means that generation of thermogenic methane will be small to nil and the ability of the coal to adsorb methane will also be low. However low rank coals can have high meso porosities compared to higher rank coals (Bustin, 1999) and can retain moderate amounts of free gas, much of which would likely be of biogenic origin. Even if gas contents are only of 1 to 3 cc/g (30 to 100 scf/ton) because of the large coal tonnages there could still be a sizable CBM resource of about 0.5 Tcf (14 billion cubic metres) concentrated in this small area.

SIMILKAMEEN COALFIELD

Tulameen sub-basin

The Tulameen and Princeton sub-basins comprise the Tertiary Similkameen coalfield (Figure 1). The Tulameen sub-basin is 20 kilometres northwest of Princeton. Underground mining carried out in the area began in 1919. Workings extended along the sub crop for 2500 metres and down dip for 800 metres. Underground mining activity diminished after a disastrous explosion that killed 45 people in 1930 (Blake, 1988) and ended in 1940. The mines extracted about 2 million tonnes from the Tulameen sub-basin. Renewed interest in the 1950's led to surface mining that extracted a further 150 000 tonnes of coal.

The sub-basin consists of an asymmetric syncline, which plunges gently to the southeast. Beds on the northwest limb dip at 40° to 65° and on the southwest limb at 25° to 49°. An area of 5 kilometres by 3 kilometres is underlain by coal-bearing Eocene sediments overlying Eocene volcanics all of the Princeton Group. The Eocene sediments are divided into 3 members with a total thickness of 780 metres.

The middle member, which is 140 metres thick, contains coal in its lower 80 metres. Coal rank is high-volatile B bituminous with Rmax% values ranging from 0.62% to 0.86% (William and Ross, 1979). Rank increases to the south.

The coal bearing section contains 2 coal seams though they tend to be very dirty with partings of shale and bentonite. The lower seam is 7 to 8 metres thick and the upper seam 15 to 21 meters thick. The seams are thought to underlie the whole basin. Based on the synclinal form of the coal horizon there is a potential coal resource of at least 200 mt And a potential CBM resource of 0.05 Tcf (1.4 billion cubic metres) in the basin.

Princeton sub-basin

The Princeton sub-basin is elongated northerly and approximately 24 kilometres long and 4 to 7 kilometres wide; it covers a total area of about 170 square kilometres. There were 13 small underground and one surface mine that operated in the central part of the basin until about 1961. The basin, which is filled with mid Eocene sediments, is more folded than the Tulameen sub-basin. Consequently, coal seam stratigraphy is not as well understood as that in the Tulameen sub-basin. In the southern part of the sub-basin 4 main coal zones were identified in a 500 metre sedimentary section. The cumulative coal thickness for the 4 seams is 17 metres, but seams are very discontinuous. Rank of the coal varies from lignite to high-volatile B bituminous.

Surface mineable reserves of about 10 mt have been quoted by a number of authors although it is difficult to estimate a resource through the southern part of the sub-basin Where Dolmage and Campbell (1975) estimate a potential resource of more than 800 mt. The low rank, uncertain coal reserve, and discontinuous nature of the coal seams limit CBM potential.

MERRITT COALFIELD

Several isolated Eocene sedimentary areas within a 15-kilometre strip between the city of Merritt and Quilchena, at the eastern end of Nicola Lake comprise the Merritt coalfield (Figure 1). The main areas are near Nicola, which underlies about 80 square kilometres, and near Quilchena, where it is about 25 square kilometres in size. In the Quilchena area a single 1.5 metre seam was explored and no significant reserves outlined. The Nicola area, which contains high-volatile C to A bituminous coal, was explored in 1945 and 1960 and about 10 mt of underground mineable reserves were outlined. There appear to be 7 seams with a cumulative coal thickness of 22 metres in a 250-metre section. Overall the Nicola coalfield has not been extensively explored but much of the area underlies the town of Merritt and some of the areas are overlain by relatively recent (500 000 years based on K/Ar dates) volcanic flows. It is difficult to estimate the resource in the area but if a coal thickness of 10 metres extends through the whole Nicola coalfield there could be over 800 mt and have a moderate CBM resource under the town of Merritt.

BOWRON RIVER

The Bowron River graben (Figure 1), which is 50 kilometres east of Prince George, is 2.5 kilometres wide and 15 kilometres long. The lower 85 meters of the more than 700 metre thick Paleocene sedimentary section is coal bearing. The coal section dips at 20° to 60° to the northeast and contains at least 3 seams with a cumulative thickness of 8.5 metres. The coal, which is high-volatile B bituminous in rank (average Rmax%=0.65%), is characterized by a high resin content (8%). Considering only the lower seam, Matherson and Sadre (1991) estimated a potential resource of 400 mt down to a depth of 1200 metres. Any CBM potential will depend on the presence of biogenic methane though the presence of amber may help initiate generation of thermogenic methane at a lower rank.

SUMMARY

There is in British Columbia, at the time of writing, a dramatic increase in interest in and exploration for CBM. There is a large coal resource in the province and the potential CBM resource is similar to that of the San Juan Basin in the United States, which is the largest CBM producer in the world. Much of the coal in the province is in the foothills of the Rocky Mountains where it has experienced a moderate amount of deformation. In this environment careful selection of drill targets and possibly novel completion techniques may be required to overcome low permeability and shearing of coal seams. The structural history is less complicated in coal areas such as at Telkwa and on Vancouver Island. Many Tertiary deposits offer the possibility of small CBM plays in part dependent on the generation of biogenic methane in the coal. The Hat Creek deposit is so large that even small concentrations of

gas could give rise to a large CBM resource.

Across B.C., there is significant potential for the development of coalbed methane. The gas is in the coal and sooner or later the forceful combination of economic incentive and human ingenuity will get it out.

REFERENCES

Bickford, C.G.C. (1989): Geology, Mining Conditions and Resource Potential of the Wellington Coal Bed, Georgia Basin (92F/1; 92G/4); in Geological Fieldwork 1988, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1989-1, pages 553-558.

Bickford, C.G.C. and Kenyon, C. (1988): Coalfield Geology of Eastern Vancouver Island; in Geological Fieldwork 1987, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1988-1, pages 441-450.

Bickford, C.G.C., Hoffman, G. and Kenyon, C. (1990): Geological Investigations in the Coal Measures of the Oyster River, Mount Washington and Cumberland Areas, Vancouver Island (92F/10,11,14); in Geological Fieldwork 1989, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1990-1, pages 431-437.

Blake, D. (1988): Blakeburn, From Dust to Dust; Wayside Press, Vernon B.C.

Bustin, R.M. and Moffat, I. (1989) Semi anthracite, anthracite and meta-anthracite in the central Canadian Cordillera: their geology, characteristics and coalification history; International Journal of Coal Geology, volume 13 pages, 303-326.

Bustin, R.M. (1999): Free Gas Storage in Matrix Porosity: A Potentially Significant Coalbed Resource in Low Rank Coals; Proceedings International Coalbed Methane Symposium 1999, May 3-7th University of Alabama, pages 197-214.

Cathyl-Bickford, C.G. (1991): Coal Geology and Coal bed Methane Potential of Comox and Nanaimo Coalfields, Vancouver Island, British Columbia; Rocky Mountain association of Geologists, pages 155-162.

Cathyl-Bickford, C.G., Wilson, R. and Hoffman, G. L. (1992): Geology, Minability and Coal Bed Gas Potential of the Douglas Coal Zone in the Nanaimo Coalfield, Vancouver Island; Canadian Coal and Coal Bed Methane Geoscience Forum, Proceedings, pages 293-309

Cathyl-Bickford, C.G. and Hoffman, G.L. (1991): Geology and Coal Resources of the Nanaimo Group in the Alberni, Ash River, Cowie Creek and Parksville Areas, Vancouver Island (92F/2,6,7,8): in Geological Fieldwork 1990, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1991-1, pages 381-385.

Church, B.N. (1977): Geology of the Hat Creek coal basin (92I/13E); B.C. Ministry of Energy, Mines and Petroleum Resources, Geology in British Columbia, 1975, pages 99-118.

Dawson, F.M., Marchioni, D.L., Anderson, T.C. and McDougall, W.J. (2000): An Assessment of Coalbed Methane Exploration Projects in Canada; Geological Survey *of Canada*, Bulletin 549.

Dow, W.G. (1977): Kerogen Studies and Geological Interpretations; Journal of Geochemical Exploration, Volume 7, pages 79-99.

Dolmage Campbell and Associates (1975): Coal Resources of British Columbia; Consultant report to British Columbia Hydro and Power Authority.

Energy Marketing Update, (1992): What is Coal bed Methane; B.C. Ministry of Energy, Mines and Petroleum Resources, Energy Market Update, Volume 4, number 1.

Feng, K.K., Cheng, K.C. and Augsten, R. (1981): Methane Desorption of Fording Coal from Greenhills Multiple Seams; Division report, CANMET, ERP/MRL 81-67(J).

Goodarzi, F. (1985): Organic Petrology of the Hat Creek Coal Deposit No 1, British Columbia; International Journal of Coal Geology, Volume 5, pages 377-396.

Graham, S.W. (1989): Geology and Coal Potential of Tertiary Sedimentary Basins, Interior of B. C.; Advances in Western Canadian Coal Geoscience-Forum Proceedings, Alberta Research Council, Edmonton, April 24-25, 1989, pages 70-89.

Grieve, D.A. (1993): Geology and Rank Distribution of the Elk Valley Coalfield Southeastern British Columbia (82G/15, 82J/2,6,7,10,11); Ministry of Energy and Mines, Bulletin 82.

Johnson, D.G.S. and Smith, L.A. (1991): Coalbed Methane in Southeast British Columbia; B.C. Ministry of Energy, Mines and Petroleum Resources, Petroleum Geology Branch, Special Paper 1991-1.

Kenyon, C., Cathyl-Bickford, C.G. and Hoffman, G. (1991): Quinsam and Chute Creek Coal Deposits (NTS (92/13,14); B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1991-3. [pages needed?]

Kenyon, C. and Bickford, C.G.C. (1989): Vitrinite Reflectance Study of Nanaimo Group Coals of Vancouver Island; in Geological Fieldwork 1988, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1989-1, pages 543-552.

Lamberson, M.N. and Bustin, R.M. (1992): Coalbed Methane Characteristics of the Gates Formation Lithotypes, Northeastern British Columbia; Canadian Coal and Coal Bed Methane Geoscience Forum, Proceedings, pages 275-284.

MacKay, B.R. (1947): Coal Reserves of Canada; Geological Survey of Canada, Report of the Royal Commission on Coal 1946.

Matheson, A. and Sadre, M. (1991): Subsurface Coal Sampling Survey Bowron River Coal Deposits Central British Columbia, (93H/13); in Geological Fieldwork 1990, B.C. Ministry of Energy and Mines, Paper 1991-1, pages 391-397.

Papic, M.M., Warren, I.H. and Woodley, R.M. (1977): Hat Creek Utilization; Canadian Mining and Metallurgical Bulletin, November 1977, pages 99-105.

Pearson, D.E. and Grieve, D.A. (1978): Coal Investigations; Crowsnest Coalfield; in Geological Fieldwork 1978, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1979-1, pages 61-65.

Pearson, D.E. and Grieve, D.A. (1985): Rank Variation, Coalification Pattern and Coal Quality in the Crowsnest Coalfield, British Columbia; Canadian Institute of Mining and Metallurgy, Bulletin, September, pages 39-46.

Proudlock, P. (1990): An Overview of Albertan and Canadian Demethanation Experience, Technology Advances and Development Potential; in Coalbed Methane in Alberta- What's it all about; Alberta Geological Survey, Information Series No 108.

Ryan, B.D. (1991): Geology and Potential Coal and Coalbed Methane Resource of the Tuya River Coal Basin; in Geological Fieldwork 1990, B. C. Ministry of Energy, Mines and Petroleum Resources, Paper 1991-1, pages 419-427.

Ryan, B.D. and Dawson, M.F. (1993): Coal and Coalbed Methane Resource Potential of the Bowser Basin, Northern British Columbia, (104H/104A); B.C. Ministry of Energy, Mines and Petroleum Resources, Open file 1993-31.

Ryan, B.D. and Dawson, M.F. (1994a): Coalbed Methane Desorption results from the Quinsam Coal Mine and Coalbed Methane Resource of the Quinsam Coalfield, British Columbia; in Geological Fieldwork 1993, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1994-1, pages 215-224.

Ryan, B.D. and Dawson, F.M. (1994): Potential Coal and Coalbed Methane Resource of the Telkwa Coalfield Central British Columbia (93L/11); in Geological Fieldwork 1993, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1994-1, pages 225-243.

Ryan, B.D. (1996): Lignite Occurrences on the Coal River Northern British Columbia (94M/10); in Geological Fieldwork 1996, B.C. Ministry of Energy and Mines, Paper 1996-1, pages 271-275.

Ryan, B.D. (1997): Coalbed Methane in the Comox Formation Tsable River Area Vancouver Island; *in* Geological Fieldwork 1996, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1997-1, pages 353-363.

Scott, A.R. (1995): Limitations and Benefits of Microbially Enhanced Coalbed Methane; *Intergas*, 95 May 15-19 University of Alabama, pages 423-432.

Smith, G.G. (1989): Coal Resources of Canada; *Geological Survey of Canada*, Paper 89-4.

Smith, L.A., UnKauf, J.C., Johnson, D.G.S. and Allen, E.J. (1992): Coalbed Methane Potential in Northeast British Columbia; *The Canadian Coal and Coalbed Methane Geoscience Forum*, Proceedings, page 147.

Williams, M.Y. (1944): Geological Reconnaissance Along the Alaska Highway from Fort Nelson, British Columbia to Watson Lake, Yukon; Geological Survey of Canada, Paper 44-28.

ABBREVIATIONS AND CONSTANTS

mt = million tonnes
scf = standard cubic foot
cm = cubic metres
cc = cubic centimetres
Rmax% = mean maximum vitrinite reflectance
psi = pounds per square inch

Volumes
1 scf = .028317 cm
1 Tcf =28.32 billion cubic metres
mcf = 1000 scf
mmcf = 1 million scf
Tcf = 1 x 10 ^12 scf
Bcf = 1 billion scf
1 scf/ton = 0.031217 cc/g or meter^3/tonne
1 m^3/tonne = 32.034 scf/ton (1 ton=2000 lb)
100 scf/ton = 3.1 cc/g

Pressures
150 scf/ton = 4.8 cc/g
1atmos =14.69 psi
200 scf/ton = 6.2 cc/g =10.33 metres water
250 scf/ton = 7.8 cc/g =101.29 kPa
300 scf/ton = 9.4 cc/g
1 psi =6.895 kPa

THE MOUNT FLEET ALKALINE COMPLEX (92I /16): A POTENTIAL PGE TARGET

By Ian C.L. Webster and Gerry E. Ray
Geological Survey Branch, Victoria

INTRODUCTION

Alkaline intrusive complexes are receiving increased exploration activity due to their potential to host platinum group element (PGE) mineralization. The Dobbin, (MINFILE 082LSW005), Maple Leaf (082ENE009) and Sappho (082ESE147) are British Columbia examples that have some tested PGE potential. The Mount Fleet Alkaline Complex has also received exploration in the past but probably deserves more concentrated efforts. Elevated values for Au, Pt and Pd have been obtained in the area from geochemical surveys and there are reports of chalcopyrite, galena and sphalerite marginal to the complex. We report here the results of a brief reconnaissance visit to the area to sample and assay for PGE.

LOCATION AND ACCESS

The area lies approximately 18 kilometres northeast of Kamloops, north of Paul and Louis lakes. Access is provided by the Paul Lake turn-off from Yellowhead Highway 5, about 3 kilometres north of Kamloops (Figure 1). A network of roads and tracks

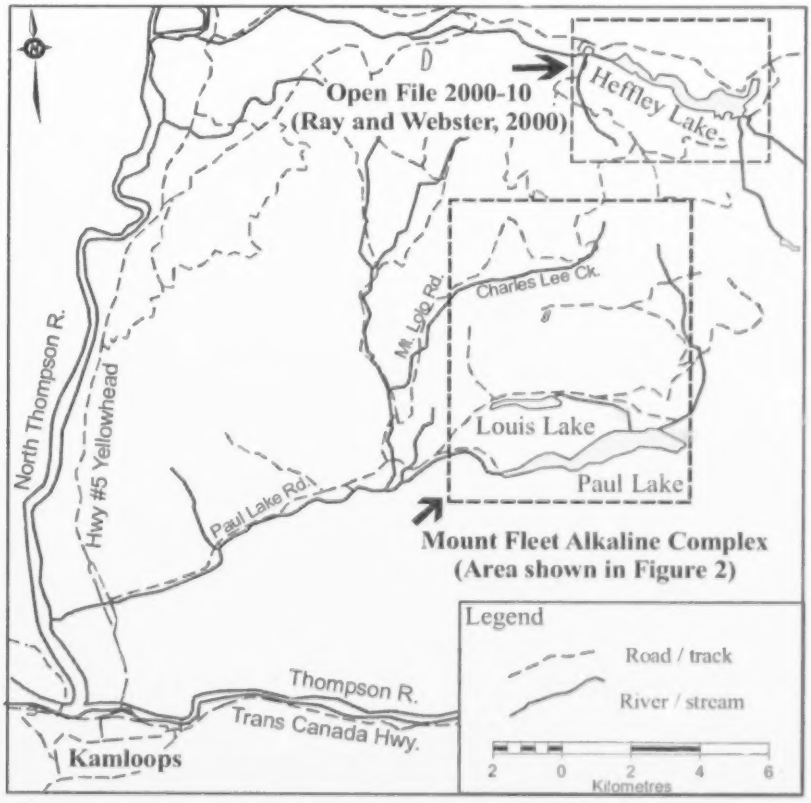


Figure 1. Location map showing the Mount Fleet Alkaline Complex and Open File 2000-10 areas.

access Mount Fleet from the east and west. A new track terminates on the upper northeast flank of the mountain, approximately 400 metres from the summit (UTM 701435E 5628265N), and probably originates as a spur on the Mount Lolo road, which roughly parallels Charles Lee Creek.

GENERAL GEOLOGY

The Mount Fleet Alkaline Complex comprises three subcircular, predominantly syenitic bodies that intrude Harper Ranch Group arc-clastic rocks. These bodies total about 64 square kilometres in area and extend northward from Paul Lake to the northern flank of Mount Lolo (Figure 2). This complex may be related to similar alkaline intrusions in south central British Columbia including diorite, gabbro, granite and ultramafic rocks, such as the Late Triassic - Early Jurassic Iron Mask Batholith (Monger and McMillan, 1984). Immediately northeast of Mt. Lolo, in the vicinity of Heffley Lake, a recently recognized mafic to ultramafic hornblende pyroxenite intrusion that occupies the contact between Devonian to Triassic Harper Ranch Group to the south and the Upper Triassic to Lower Jurassic Nicola Group to the north (Ray and Webster, 2000 a, b), may also be related to the Mount Fleet Alkaline Complex. Similarities also appear to exist between the Mount Fleet and Whiterocks Alkaline Complexes. The Whiterocks complex hosts the Dobbin Cu, PGE occurrence (Nixon & Carbno, 2001).

PREVIOUS WORK

Kwak (1964) mapped and described the main features of the Mount Fleet Alkaline Complex. He described seven main intrusive phases of the complex including two layered lenses of shonkinite. These lenses occur within a mafic phase of the syenite, near the centre, and comprise mainly microperthite, andradite garnet and aegirine augite.

Kennco Explorations undertook geophysical and geochemical surveys over part of Mount Fleet in 1970. Culbert (1988) mentions that Kennco Explorations reported irregular interstitial pyrrhotite and chalcopyrite from the complex. The Kennco Explorations geology map (Ney, 1970) shows three large mafic syenite bodies on the northwest flank of the mountain, however neither the soil sampling nor geophysical surveys covered this area. Their work was concentrated in the vicinity of the small lake near the middle of the central body (Figure 2).

Duval Corporation investigated the potential for carbonatite-hosted rare-earth elements in the Mount Lolo area in 1982 (McCarthy, 1989). Elevated Au values were found in pan concentrates taken from the creek draining northward into Heffley Lake and the following year elevated Au was found in silt samples taken from intermittent drainages on the south slope of Mount Lolo.

A regional geochemical survey conducted in 1986 identified elevated Au, Ag, Pt and Pd in the vicinity of Mount Lolo which Asamera Resources further investigated (McCarthy 1988, 1989). Silt samples taken from a stream draining northward into Little Heffley Lake, from the northern flank of Mt. Lolo, contained elevated Au values, up to 780 ppb and a single elevated Pd value of 75 ppb near the headwaters (McCarthy, 1988). A line of soil samples, taken roughly parallel to the 5,000 foot contour on the northeast flank of Mount Lolo, contained elevated Pt compared with the values from the other soil lines. The elevated Au values were attributed to mineralized quartz veins surrounding the small syenite stock on the north side of Mount Lolo. These veins are reported to contain galena, pyrite and trace sphalerite. In addition, syenite float boulders in the area contain minor chalcopyrite. Rock samples taken in this locality the following year were not analyzed for PGE or Cu.

Redbird Gold Corp. explored the area northeast of Mount Lolo, south of Heffley Lake, in 1987. Seven heavy mineral samples were collected from a northward flowing stream that enters Heffley Lake. One of the samples contained values of 1.390 ounces per ton Au and 0.109 ounces per ton Pt (Roed, 1988). The stream drains an area underlain, for the most part, by the mafic-ultramafic Heffley Creek Pluton (Ray & Webster, 2000a, b). An actinolite-rich hornblendite boulder found near the centre of the mafic intrusion, east of the creek, assayed 90 ppb Pt (Roed, 1988) suggesting that this body may have PGE potential.

Equinox Resources Ltd. conducted geochemical sampling and prospecting in 1988 around the summit and on the northeast shoulder of Mount Fleet. The program was designed to test for Au, Pt and rare earth elements in the complex. Soils were analyzed for Au, Ag, As, Cu, La and Ni. La was considered to be representative of rare earth elements and Ni for PGE. Rock samples were assayed for Au, Pt, Pd and Rb but there were no encouraging results. However, the mafic rocks and shonkinite near the centre of the intrusion may not have been sampled. The soil sam-

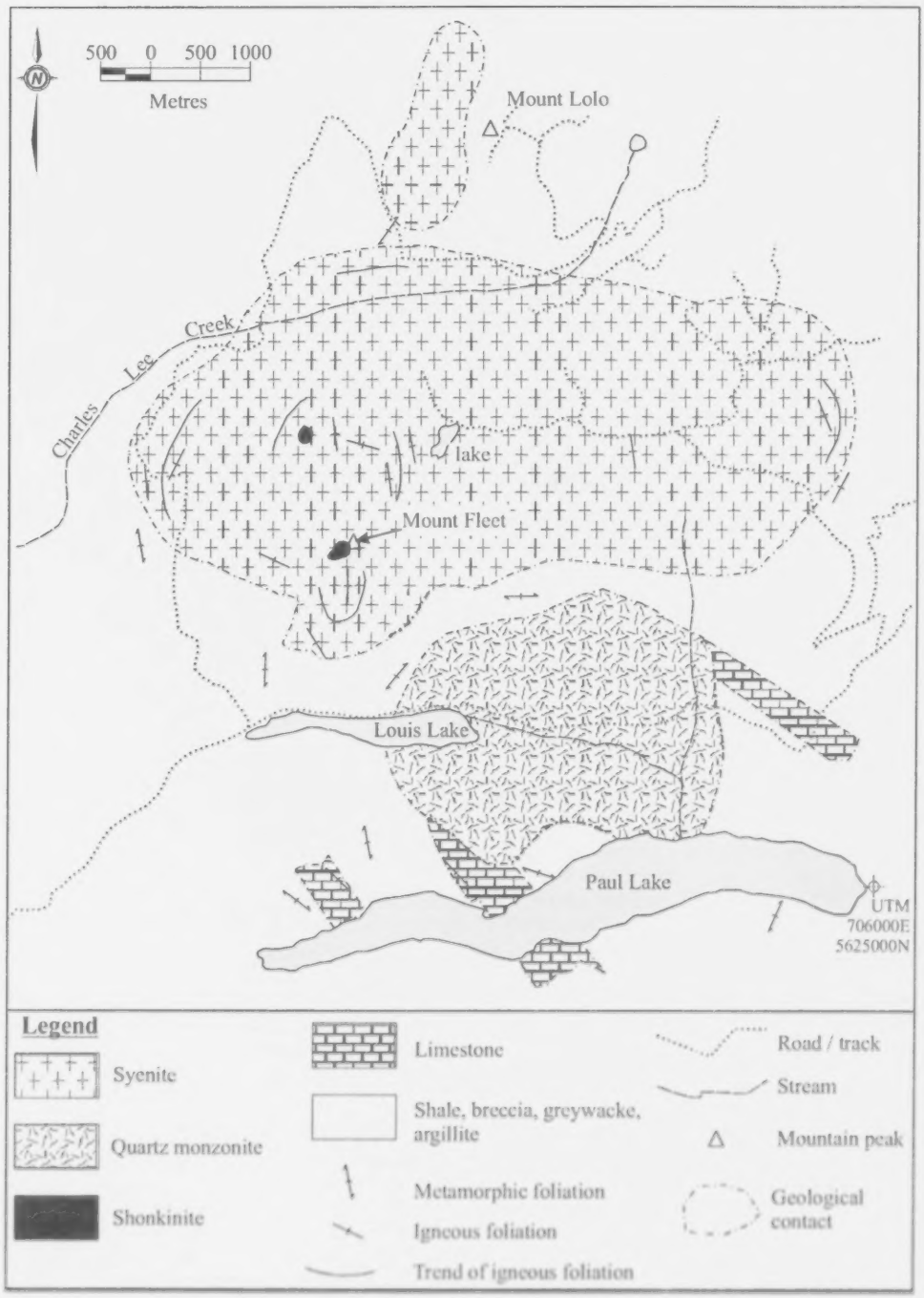


Figure 2. Geology of the Mount Fleet Alkaline Complex, simplified after Kwak (1964).

ples did define a belt of elevated Cu and La (Culbert, 1988).

DETAILED GEOLOGY

Three subcircular intrusive bodies comprising the Mount Fleet Alkaline Complex range in composition from quartz monzonite to monzo-syenite to syenite. Textures are generally coarse to very coarse with feldspar crystals up to 10 centimetres in length and often aligned parallel. Kwak (1964) reports a concentric pattern, especially in the central body, related to alignment of feldspar crystals and an increase in mafic minerals towards the centre (Figure 2). He also reports two zones of thinly layered shonkinite, containing chiefly euhedral andradite garnet, aegirine augite and alkali feldspar, that occur in the most mafic part of the body near the centre. The northern body which underlies part of Mount Lolo is comprised, for the most part, of syenite whereas the southern body is quartz monzonite with a fine-grained border and a porphyritic coarse-grained core. The presence of possible igneous garnet is also reported in the Whiterocks Mountain Alkaline Complex (Nixon and Carbno, 2001).

An outcrop of megacrystic syenite, on the north side of Mount Lolo, was sampled for uranium/lead isotopic dating and has yielded a preliminary age of Early Jurassic (Richard Friedman, personal communication, 2001). This age probably represents the time of emplacement for the Mount Fleet Alkaline Complex. The spatial association of this syenite with the mafic-ultramafic body south of Heffley Lake, less than one kilometre, suggests that the Mount Fleet Alkaline Complex may be related to the Heffley Creek Pluton.

The authors effected a one day traverse in the vicinity of Mount Fleet to collect samples for assay from the shonkinite. Access was gained by driving to a small lake 1 kilometre northeast of the mountain and then walking to the top of Mount Fleet. Subcrop near the lake (UTM 701879E 5628460N) is coarse-grained grey syenite with potassium feldspar crystals up to 2 centimetres long. The rock contains about 5 per cent amphibole with possible accessory garnet. Six hundred metres northeast of the peak (UTM 701667E 5628294N) massive salmon-pink coloured, coarse-grained porphyritic feldspar syenite outcrops with crystals up to 1.5 centimetres long. Amphibole crystals comprise about 2 to 3 per cent.

Sub parallel aligned feldspar crystals, trending 160 degrees, impart a layering in coarse-grained pink syenite near the top of Mount Fleet (UTM 701215E 5628066N). Amphibole comprises 8 to 15 per cent of the syenite with garnet and pyroxene accessories.

A number of mafic, hornfelsic, magnetic, garnet-bearing float boulders occur in the vicinity of UTM 701234E 562799N. Float samples GR00-20 and 21 were taken for assay and did show elevated values for Au, Cr and Ni (Table 1, next page). Samples GR00-22, 23 and 24 were taken in the vicinity of UTM 701044E, 5627915N. These samples probably represent the shonkinite described by Kwak (1964) however we were unable to locate the larger occurrences he describes, given the short duration spent in the area. The samples collected were of rusty weathering garnet and pyroxene-rich zones, with trace pyrite, occurring within coarse-grained syenite. Locally there are 1 centimetre thick layers of more mafic (>50% mafics), finer grained material interlayered with 1-4 centimetres thick layers of more felsic syenite. Ce and La are elevated in these samples.

Samples GR00-25 and 26 were taken in a southerly trending draw on the southeast side of the summit (UTM 701084E 5627884N). Layers of orange weathering, magnetic shonkinitic rock were sampled including a 1-2 centimetre wide pod of magnetite. PGE values were not elevated, but again, the rare earth elements Ce and La are somewhat elevated.

SUMMARY AND CONCLUSIONS

The association of PGE with alkaline complexes in south-central British Columbia makes the Mount Fleet Alkaline Complex a potential target. Previous PGE exploration in the area was directed more toward the mafic rocks south of Heffley Lake or the sedimentary rocks on the margins of the Mount Lolo syenite. Some exploration work has occurred over the Mount Fleet area. However the area underlain by the mafic syenite and shonkinite was not directly tested for PGE. Although the results presented herein are not particularly encouraging, more work is required to adequately test the area. Detailed geological mapping and systematic sampling, especially of the mafic and shokinitic phases is required. Alteration around the margins of the complex should be mapped and sampled: there is potential for skarn mineralization where limestone is mapped. Detailed stream sediment sampling, especially in those areas already identified as having elevated PGE values, may prove valuable.

Table 1. Assay data of rock samples collected from the Mount Fleet Area.

Sample No.	GR00-19	GR00-20	GR00-21	GR00-22	GR00-23	GR00-24	GR00-25	GR00-26
Au	<0.03	0.15	0.51	<0.03	<0.03	<0.03	<0.03	<0.03
Pt	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Pd	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Rh	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
As	3	6	<1	<1	2	11	<1	<1
Hg	<10	<10	<10	<10	<10	<10	<10	<10
Al	7.98	7.75	1.78	8.33	8.38	8.94	9.03	8.74
Sb	0.1	0.2	1.1	0.1	<0.1	<0.1	<0.1	<0.1
Ba	1680	1040	10	2330	5690	1210	1780	1850
Be	1.8	2.85	0.15	1.75	0.6	1.65	1.25	1.05
Bi	0.02	0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.02
Cd	0.16	0.2	0.18	0.1	0.08	0.1	0.06	0.06
Ca	3.16	5.95	10.2	1.84	1.2	1.61	1.92	1.37
Ce	67	39.3	5.44	58.3	110.5	105.5	64	115
Cs	1.1	2.1	0.05	1	3.1	1	3.25	0.85
Cr	45	303	243	42	42	42	37	46
Co	7.6	32.2	61.3	4	5	2.2	8.6	2.2
Cu	113	28	<1	31	32	19	23	19
Ga	21	16.6	10.6	21	20.4	19.9	24	19.1
Ge	1.4	1.3	1.7	1.3	1.3	1.2	2	1.3
Fe	2.8	5.62	8.4	3.12	4.64	3.27	6.15	3.23
La	35	17.5	2	28.5	55.5	51	33	50.5
Pb	8	8.5	0.5	8.5	9	10	8.5	9
Li	10.8	11.6	7.4	8.2	36.8	20	52	13.4
Mg	0.63	4.17	6.92	0.63	1.36	0.82	1.43	0.68
Mn	685	1125	1065	775	1385	1230	1715	975
Mo	<0.2	2	<0.2	1	0.2	1	0.2	1.4
Ni	6	88.5	90.4	3	6.2	2.8	4.2	1.6
Nb	23.6	6.8	<0.2	14.6	17	13.4	9.4	14.4
P	1460	2470	40	520	1010	1130	1630	1610
K	6.72	2.56	0.03	6.37	6.84	3.75	3.9	4.79
Rb	135	109.5	1.6	110	173	60.6	120	73.8
Ag	0.6	0.2	<0.05	0.35	0.4	0.3	0.25	0.35
Na	2.96	2.2	0.14	3.36	2.47	5.25	3.82	4.52
Sr	1800	797	56.9	1415	789	593	658	369
Ta	1	0.3	<0.05	0.6	0.85	0.6	0.45	0.7
Te	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tl	0.38	0.14	<0.02	0.36	0.56	0.24	0.62	0.32
Th	4.4	4.4	<0.2	3.2	5.8	5.6	4.8	6.6
Ti	0.45	0.61	0.48	0.32	0.69	0.56	0.54	0.5
W	0.3	0.4	0.1	0.1	0.2	0.3	0.1	0.1
U	1.6	1.8	<0.2	1	1.8	1.6	1.4	2
V	188	234	397	153	134	99	204	84
Y	18.4	20.1	9.2	15.6	34.9	34.1	25.1	37.3
Zn	64	92	48	64	142	104	114	70

Analytical methods, sample location & descriptions (UTM – NAD 83). All sample analysed by:
ALS Chemex, Aurora Laboratory Services Ltd., 212 Brookbank Ave, Vancouver, BC, V7J 2C1
Methods used for all data in this table: Au, Pt, Pd, Rh = Fire assay - ICP; Other elements = ICP-MS Ultratrace.
Au, Pt, Pd, Rh = g/tonne; Hg = ppb; Al, Fe, Ca, Mg, K, Na, Ti = per cent; other elements in ppm.
GR00-19 7012135E 5628066N Coarse feldspar syenite with 8-15% mafic minerals, near the summit of Mt. Fleet.
GR00-20 7012134E 5627999N 15 cm wide piece of magnetic, garnet-bearing "hornfels float.
GR00-21 7011150E 5627930N 15 cm piece of magnetic ultramafic serpentinite-bearing float.
GR00-22 7010044E 5627935N Mafic "shonkinite" with >50% pyroxene & garnet, trace pyrite.
GR00-23 7010044E 5627935N Mafic "shonkinite" with >50% pyroxene & garnet, trace pyrite.
GR00-24 7010044E 5627935N Mafic "shonkinite" with 20% "segrete-augite.
GR00-25 7010064E 5627906N Mafic, magnetite-bearing "shonkinite".
GR00-26 7010964E 5627864N Mafic, magnetite-bearing & rust-stained "shonkinite"

ACKNOWLEDGMENT

We thank Nick Massey for providing a timely and helpful editorial review of this manuscript.

REFERENCES

Culbert, R. (1988): Geochemical and Prospecting Report - Flee 1and Flee 2 Claims; *British Columbia Ministry of Energy, Mines and Petroleum Resources;* Assessment Report 18 249

Kwak, T.A.P. (1964): A garnet-bearing syenite near Kamloops, B.C.; unpublished M. Sc. thesis, University of British Columbia, 53 pages.

Monger, J.W.H. and McMillan, W.J. (1984): Bedrock Geology of Ashcroft (92I) Map Area; Geological Survey of Canada Open File 980.

McCarthy, P.D. (1988): Lolo Claims - Geochemistry and Prospecting, *British Columbia Ministry of Energy, Mines and Petroleum Resources,* Assessment Report 17 121.

McCarthy, P.D. (1989): Lolo Claims - Geochemical Program 1988, *British Columbia Ministry of Energy, Mines and Petroleum Resources,* Assessment Report 18 371.

Ney, C.S. (1970): Report on Geological and Geochemical Surveys - Mt. Fleet Claim Groups; *British Columbia Ministry of Energy, Mines and Petroleum Resources,* Assessment Report 2 586.

Nixon, G.T. and Carbno, B. (2001): Whiterocks Mountain Alkaline Complex, South-Central British Columbia: Geology and Platinum-Group-Element Mineralization; *in* Geological Fieldwork 2000, *British Columbia Ministry of Energy and Mines,* Paper 2001-1, pages 191-222.

Ray, G.E. and Webster, I.C.L. (2000a): The Heff Prospect at Heffley Lake , South-Central B.C. (091INE096): An Unusual Example of a Mafic-ultramafic-related Cu-Au-REE-Bearing Magnetite Skarn; *in* Geological Fieldwork 1999, *British Columbia Ministry of Energy and Mines,* Paper 2000-1, pages 273-286.

Ray, G.E. and Webster, I.C.L. (2000b): Geology of The Heffley Lake Area, South Central British Columbia, *British Columbia Ministry of Energy and Mines,* Open File 2000-10.

Reed, M.A. (1988): Geology of the Hawk 5 to 8 Claims; *British Columbia Ministry of Energy, Mines and Petroleum Resources;* Assessment Report 17 803

1999-2000 BRITISH COLUMBIA PROSPECTORS ASSISTANCE PROGRAM

By Garry Payie, P. Geo.
Program Coordinator

HIGHLIGHTS

Prospectors in the 1999-2000 program year were successful at finding a number of new mineral occurrences in British Columbia. To date, six prospectors have entered into agreements with companies for the following seven properties.

Aumax – a gold vein showing and scattered boulders with high-grade silver and gold near Lillooet. Discovered by Gary Polischuk. Optioned in fall 1999 to **Gold-Ore Resources**.

Cly – a potential bulk-tonnage gold prospect near Nelson discovered by William Howard. Optioned to private interests.

Demers – an extensive new zinc-copper anomaly near Little Fort located by Robert Bourden and optioned to a mining concern in the summer of 2000.

McPhee – high-grade gold-bearing quartz veins south of Nelson. Discovered by Bruce Doyle. Optioned to **Cassidy Gold Corp**. who could spend $500,000 on the property over a period of four years.

Carbonado and **Mark** – Dave Javorsky restaked two known prospects with potential for diamonds, near Golden. These properties were optioned to **Icefield Diamond Mines** and **Kootenay Diamond Mines** respectively in early 2000.

Zinger – Peter Klewchuk discovered several new gold-bearing silicified zones southwest of Cranbrook. Optioned to National Gold Corp. in late 2000 with the agreement calling for $750,000 to be spent on exploration over a four-year period.

Prospectors funded through this program made several other significant new discoveries, some of which also have excellent potential for being optioned.

There is also ongoing exploration on Prospectors Assistance discoveries made in previous years. For example, a total of $850,000 dollars has been spent on the Lottie Lake property since its discovery in 1997.

INTRODUCTION

Energy and Mines Minister Dan Miller announced the renewal of the 1999-2000 Prospectors Assistance Program (PAP) on April 9, 1999. The $500,000 per year program is designed to promote grassroots prospecting for new mineral deposits in British Columbia.

The program is available to individual prospectors who hold a valid British Columbia Free Miners Certificate. Successful applicants can receive a maximum of $10,000 to cover 75% of their eligible expenses. The grant is paid in 2 amounts, an initial 50% award on approval of the project proposal and a final 50% award upon approval of the final report.

PROSPECTING PROGRAMS

Deadline for applications was set for the third Monday in April - in the 1999 program year, April 19. A total of 137 applications were received by the deadline. All applications were initially reviewed by the Victoria office to ensure that they met the criteria as outlined in the guidebook. Qualifying applications were then sent to the appropriate Regional Geologist for evaluation by May 15. Applications were evaluated on the basis of the following criteria:

- Quality and documentation of proposal 45%
- Financial commitment of applicant 25%
- Experience and training of applicant 10%
- References and past performance 20%

The five Regional Geologists reviewed all applications for their respective regions and rated them according to specific evaluation guidelines.
Grant amounts were determined by allowing the 26 highest rated applicants 100 per cent of their maximum allowable grant (to a maximum of $10,000)

Figure 1. Distribution* of 1999 Prospector Grant Projects

*Some programs have multiple prospecting locations and have been assigned more than one plot symbol

and the following 25 applicants, 75 per cent of the maximum allowable grant (up to $7500). A total of 51 grants averaging $8,525 were approved in 1999-2000.

The prospecting programs were distributed throughout the province as shown in Figure 1. Of the 137 applicants, 68 (49.6%) had never received a grant before. Of the 51 applicants receiving grants, 19 (37.3%) had never received grants before.

Final prospecting reports were due in the Victoria office no later than January 31, 2000. These reports were logged in and sent off to the appropriate regional geologist for evaluation. The quality of the program was assessed by the regional geologist in terms of the commitment and ability of the grantee to carry out the program as originally proposed. Program elements looked for in the report included the plotting of sample locations and other data on good maps, a good diary of day to day prospecting activities, a summary of overall results and a list of actual expenditures along with major receipts.

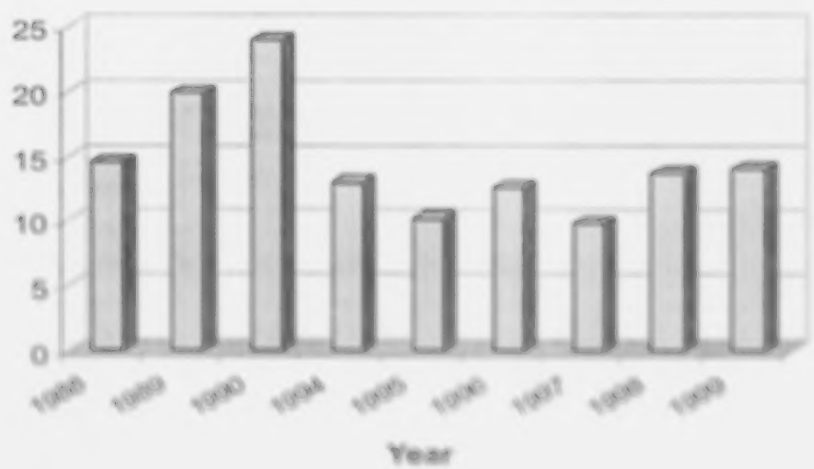
The final report evaluation form was returned to Victoria where a final payment cheque was issued to those grantees that had successfully completed their program.

Twenty-six of the 49 grantees active (those who completed their program) staked mineral claims while working under the terms of their grant. A total of 687 units were staked (Table 1). This is up

Table 1. Summary of Prospecting Activities.

Item	1988-89	1989-90	1990-91	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
Total Prospecting days in the field	4709	3414	2672	2816	2440	3102	1846	2459	2704
Average prospecting days in the field, active grantees	37	46	35	45.4	41.3	51.7	45	50	55
No. of Active Grants	128	74	76	62	59	60	41	49	49
No. of claim units staked during/after prospecting activity	1860	1483	1843	816	604	759	403	672	687
No. of Units Staked/Active Grantees	14.5	20	24	13	10.2	12.6	9.8	13.7	14
No. of Option agreements (signed or under negotiation)	23	8	6	15	16	14	2	8	7

Figure 2. Claim units staked/grantee.



slightly from the previous year and is consistent with staking levels since 1994 (see Figure 2). The fewer numbers of claims staked after 1994 reflects a depressed market for exploration properties that has continued through much of the 1990s.

RESULTS TO DATE

The following notable developments and prospecting discoveries are an indication of the program's value in the search for untapped mineral wealth, the first step towards developing tomorrow's mines for British Columbia.

New Discoveries and Developments

Robert Anderson discovered numerous agate and common opal occurrences and staked several claims in the Burns Lake area.

Camille Berube located an area of scheelite-bearing skarn and pegmatite boulders in the "Water Tank" area of the **Lucky Bear** claims. A grab sample collected by regional geologist Mike Cathro yielded 0.44% tungsten, 0.15% zinc and 205 ppm bismuth.

Dave Bennett located several unstaked gold anomalies, which will be followed up in 2000.

Arndt Burgert discovered a 20-centimetre thick lens of massive sulphide while exploring an area north of Powell River in 1998. Follow-up work on his **Lorax** property in 1999 turned up a second lens measuring up to 0.7 metres thick. This VMS style mineralization is hosted in felsic rocks of the Gambier Group. Samples yielded peak values of 7.38% zinc, 1.90% lead, 0.7% copper, 211 g/t silver and 2.6 g/t gold.

Dan Ethier explored his **Knoll** property, a massive sulphide target associated with a Cretaceous submarine rhyolite dome. Rhyolite containing 1 to 6% pyrite occurs over a 3 kilometre strike length. Values of 0.12 to greater than 1% zinc were obtained from rock samples over a 275 metre length. Significant values in lead and silver were also reported.

Warner Gruenwald discovered several new pegmatite-related Au-W-Cu-Bi skarn occurrences northeast of Shuswap Lake and the **GQ** claims were staked in the fall of 1999. Calc-silicate quartz-sulphide zones occur over an area of 1.5 by 1.5 kilometres and anomalous gold values occur at several showings. Mineralization consists of 10 to 30-centimetre wide lenses of calc-silicates, quartz and sulphides along the margin of pegmatite where in contact with marble or schist (Shuswap metamorphic complex). Gold ranges up to 3 g/t.

Dave Haughton discovered a new magmatic nickel-copper showing near Harrison Lake. The **Jason** claims were staked over an area of previously unidentified outcrops of ultramafic rock and hornblendite. Polished sections showed net texture sulphide consisting of pyrrhotite, pyrite, chalcopyrite and exsolved pentlandite. Maximum values obtained from float and outcrop include 0.22% nickel, 0.20% copper and 0.14% chromium. Associated elevated platinum and palladium values also occur.

Ralph Keefe discovered a new massive sulphide (skarn?) showing and staked the **Chess** claims. The prospect is reported to occur continuously throughout a large rock quarry that is 90 metres long by 15 metres wide.

John Kerr located a new showing near Rock Creek. A narrow shear in a gossanous rock was revealed to host gold, silver, lead and zinc. The **JJ** and **J&J** claims were staked.

Leo Lindinger discovered a quartz vein stockwork in intrusive rocks near Blue River with up to 0.2% Cu and 0.09% Mo. He staked the **Cu-Mo** claims to cover the new occurrence.

Bill Poole discovered a new wollastonite occurrence on the **Murray** claims northwest of Quesnel.

Dave Ridley discovered a new W-Mo skarn showing northwest of Canim Lake. Ridley staked the **Fox** claims to cover the showings that yielded up to 3.1% Mo, 1.6% W and 0.15% Zn in garnet-diopside(?)-actinolite-wollastonite skarn.

Dennis Schaefer discovered good quality precious opal on his **Firestorm** claims near Burns Lake.

John Telegus has further defined a previously known gold showing near Ursus Creek on central Vancouver Island. Samples of quartz vein from the **Thunder** claims (Elmer zone) yielded up to 38 g/t gold.

Adam Travis explored his **Nicol Creek** property where he located narrow, massive tetrahedrite veins and numerous new geochemical anomalies.

Shawn Turford discovered massive sulphides occurrences with zinc, copper and gold on his TSA project; and copper, silver and gold on his Comb project.

Lorne Warren explored his **Vent** and **Diver Lake** properties, east of Takla Lake, for VMS mineralization. He identified several zones of alteration and/or mineralization within rocks of the Sitlika assemblage.

Paul Watt found a new (epithermal?) Au vein occurrence northwest of Little Fort.

PROPERTIES OPTIONED

Aumax

Gary Polischuk worked on his Aumax property, located near Lillooet. Two mineralized zones have been discovered, a mesothermal gold-quartz vein showing, and float boulders of high-grade silver-gold vein material. This property was optioned briefly in the fall of 1999 to **Gold-Ore Resources** but was dropped because the high-grade Ag-Au was found to be coming from transported rock material.

Cly

Located southwest of Salmo, the Cly prospect was staked by **William Howard** to cover a potential bulk-tonnage gold prospect with many characteristics of the plutonic-related gold model. The Cly was optioned to private Alberta interests for a $30,000 commitment in 2000.

Demers

Robert Bourdon located an interesting 10-kilometre long, linear Zn-Cu-Cd-As-Sb-Ba-Hg anomaly in till and soil. The bedrock source has yet to be determined. This was a follow-up of high geochemical values from a Geological Survey Branch till survey northwest of Little Fort. Bourdon and partner Lloyd Addie staked the Demers claims to cover the prospect and optioned it in the summer of 2000. Details of the option are confidential.

McPhee

Bruce Doyle discovered several gold-bearing quartz veins on his McPhee claims east of Castlegar. **Cassidy Gold Corp.** recently took an option on this new find. The property hosts gold-bearing veins in weakly altered, fractured granitic rocks. A chip sample from one vein assayed 202 grams per tonne gold and 127 grams per tonne silver over 0.3 metres. Visible gold can be seen in several locations along this steeply dipping vein. Other gold-bearing veins have been located more than 50 metres from the discovery site. Cassidy must make staged cash payments totalling $100,000, issue 200,000 common shares, and spend at least $500,000 in exploration and development work on the property over a period of four years. Five short holes were drilled in 2000.

Carbonado

Initially staking the Carbonado claim to cover the **Jack** alkaline diatreme near Golden, **Dave Javorsky** later optioned the property to **Icefield Diamond Mines** in early 2000. In 1983, treatment of seven bulk samples from an upper breccia portion of the diatreme produced pyrope garnets, ilmenites and chromites. More significantly, one 29.5-kilogram bulk sample of sandy marl from the diatreme breccia was reported to have produced an excellent quality octahedral microdiamond weighing 0.000377320 carats. Further sampling and analysis and diamond drilling in 1985 and 1986 failed to confirm the presence of macro or microdiamonds. Icefield must spend a minimum of $25,000 on the property in 2000.

Grantee	Optionee	Amount	Comments
Robert Bourdon	Confidential	undisclosed	Demers claims
Bruce Doyle	Cassidy Gold Corp.	$500,000 over 4 years	McPhee property
William Howard	Private Interests	$30,000 in 2000	Cly property
Dave Javorsky	Kootenay Diamond Mines	$25,000 in 2000	Mark property
Dave Javorsky	Icefield Diamond Mines	$25,000 in 2000	Carbonado claim
Gary Polischuk	Gold-Ore Resources	$20,000 (estimated)	Aumax claim
Peter Klewchuk	National Gold Corp.	$750,000 over 4 years	Zinger claims
	TOTAL	**>$1,350,000**	

Table 2. Option Agreements Reported by 1999 Grantees as of January 2001.

Mark

Dave Javorsky staked the Mark 2000 and Mark 2001 claims to cover the Mark alkaline diatreme near Golden and was later able to option the property to **Kootenay Diamond Mines** in early 2000. In 1983, a 30-kilogram portion of a 160-kilogram bulk sample of a diatreme produced one ilmenite and thirteen chromites and one 0.00015820-carat microdiamond fragment. Further examination, sampling, processing and analysis in 1986, 1988 and 1990 has identified ilmenite, chromite and garnet but failed to reveal or substantiate the presence of macro or microdiamonds. However, scanning electron microscope (SEM) studies identified corundum - several blue sapphires were present in the fused concentrates of three samples of diatreme material. Kootenay Diamond Mines must spend a minimum of $25,000 on the property in 2000.

Zinger

Peter Klewchuk discovered several new gold-bearing silicified zones about 30 kilometres southwest of Cranbrook and staked the Zinger claims. Bedrock sampling indicates gold mineralization is scattered over an area measuring 3.5 square kilometers. Soil sampling over three discontinuous grids further expands the area of mineralization over an additional 1 square kilometer area. To date the limits of the scattered gold mineralization on the property have not been defined. Klewchuk optioned the property to National Gold Corp. in the fall of 2000. National Gold must spend $750,000 on exploration over a four-year period.

ACTIVE PROPERTIES DEVELOPED BY PREVIOUS GRANTS PRIOR TO 2000

The following are only the known active properties picked up by companies because of work done by PAP grantees under previous programs during from 1988 to 1998. The actual amount of exploration activity flowing from PAP sponsored discoveries is likely to be far greater than that captured below.

Anglo-Goldenex

In 1995, **David Javorsky** received a grant to work on the Anglo property near Lillooet. In 1995, the property was combined with the adjacent Goldenex property of Gary **Fullerton** and optioned to **Homestake Canada Inc.**, who held the property from 1996-1997, drilled 28 holes totalling 4000 metres, spent over $600,000 and discovered a new, shallowly dipping mesothermal gold prospect. In 1999, **Gold-Ore Resources Ltd.** drilled an additional nine holes to better define a moderate to high-grade (7 to 31.5 g/t Au) northeast-plunging gold shoot, 50 to 100 m wide, 1.5 to 8 metres thick and at least 200 metres long, which is open down-plunge to the northeast. Gold Ore spent approximately $250,000 on the property since 1998. The property was returned to the vendors in late 1999.

Bow

In 1997, two areas of copper±zinc±gold±silver float were staked by **Martin Peter** southeast of Prince George, a direct result of a $5721 PAP grant. Samples of massive fine-grained pyrite with faint bands of chalcopyrite, yielded up to 7% copper, 1% zinc, 4 g/t gold and 7 g/t silver. **Eureka Resources Inc.** optioned Peter's Bow and Tow claims in December 1997 and identified two prominent airborne EM conductors in 1998. Follow-up surveys further defined the VMS targets, which the company planned to drill in 1999. Estimates of expenditures in 1998 are $140,000. Eureka subsequently optioned the Bow to Hudson Bay Mining and Smelting in 1999 who spent $650,000 on exploration in 2000 on the combined Bow and Lottie properties (a group of 850 contiguous claims). Eureka announced in January of 2001 that Hudson Bay would not be exercising its option to conduct further exploration on the Lottie Lake Property.

Bizar/Goldstrike

Located near Blue River, the Bizar prospect is a gold-bismuth-copper prospect discovered by **Lee Lindinger** during the execution of his 1998 PAP program, for which he received a $10,000 grant. Quartz-sulphide veins cut micaceous quartzite and mica schist. A chip sample across a 20-centimetre vein yielded 56 g/t gold, 0.5 per cent bismuth and 0.54 per cent copper, along with anomalous silver, cobalt, molybdenum, nickel, selenium, tellurium and tungsten. **Cassidy Gold Corp.** optioned the Bizar claims in 1998 and renamed the property **Goldstrike**. Cassidy drilled five short holes in late 1999, intersecting several narrow veins with anomalous gold values. The best was 6 g/t over 20 centimetres. The company reported $46,762 in expenditures in 1999. A total of $300,000 was to be spent by the end of the fourth year. Further worked is expected in 2000.

Cam-Gloria

Located west of Adams Lake, the Cam-Gloria gold prospect was discovered by prospector **Camille Berube** in May 1997 while following up two anomalies from a BC Geological Survey till geochemistry survey. A quartz vein hosted by granitic rocks contains pyrite, pyrrhotite, and rare galena and chalcopyrite and is up to 10 metres wide and 200 metres in length. Berube conducted blast trenching, hand trenching and geochemical sampling of the vein in 1998, supported by a $10,000 PAP grant program. In mid 1999, the property was optioned to **Teck Corporation** who conducted a mapping program followed by excavator trenching and the drilling of 7 holes. The Teck work shows that the vein system consists of a series of sub-parallel quartz veins within a sericite-altered zone up to 40 metres wide. The area of alteration and veining has now been traced along strike for about 700 metres. Expenditures by Teck in 1999 were approximately $100,000. The property was returned to Berube in 2000.

Dominion Creek

Allan Raven's 1998 prospecting grant provided funding that was instrumental in acquiring the additional data necessary to promote the property and finally option it in 2000 to **Gold City Industries Ltd.** The Dominion Creek property, northeast of Wells, hosts a series of auriferous quartz-sulphide vein, stringer and replacement zones. Mineralization is lithologically and structurally controlled and occurs within argillaceous limestone of the upper Isaac Formation. A bulk sample comprised of material from the 2B and 3B veins totalled 119 tonnes and averaged 14.1 g/t Au. Expenditures by Gold City in 2000 totalled $220,000.

Findlay Creek

These properties are located 35 kilometres northwest of the Sullivan Mine and cover the same stratigraphic sequence which hosts this world-class deposit. **Tim Termuende** staked mineclaims in the Findlay Creek area in early 1989 in anticipation of an airborne geophysical survey flown by the B.C. Geological Survey and the Geological Survey of Canada. Termuende was able to carry out initial prospecting on the Cow, Pat and Duc claims in 1995 after receiving a PAP grant in the amount of $8,800. Later in the same year, the claims were leased to **Eagle Plains Resources** and **Wings River Resources** who did follow-up work in 1996, including drilling.

Kennecott Canada Exploration Inc. optioned the property in 1996 and carried out $1.3 million worth of work in 1997 and 1998 including the drilling of 5 holes. An extensive sheeted vein system containing lead and zinc (with accessory cadmium, copper and tungsten) mineralization was encountered in one drill hole. Another drill hole tested an extensive tourmalinite alteration zone and encountered significant base-metal enrichment over 105 metres. Within this interval, 46 individual thin stratabound mineralized horizons were intersected. Kennecott, electing to direct its exploration southward, dropped the Findlay option in 1999 and picked up the adjoining **Greenland Creek** option from Eagle Plains and Miner River. Kennecott spent $240,000 on a first phase program in 1999. In 2000, Kennecott drilled a single 295 metre hole, which was to test a prominent zinc in soil geochemical anomaly delineated during the 1999 program field season. The hole intersected a thick gabbro sill from 90 metres to 209 metres, then at 228 metres the hole entered granitic pegmatite that persisted to the bottom of the hole. Kennecott decided in 2000 not to continue with the option. **Rio Algom Exploration Inc.** took an option on the **South Findlay** property (a portion of the original Findlay Creek property) in early 1999. The company drilled 2,578 metres in three holes in 2000 and subsequently terminated their option. Some of the results, however, were reported to be encouraging. **Billiton Exploration Canada Limited** entered into an agreement with Eagle Plains in the spring of 1999 to option the **North Findlay property**, the remaining 149 claims of the original Findlay Creek property. Eagle Plains used partial funding from the financing as operator, to carry out a $400,000 diamond drilling program during 1999. It was announced in March 2000 that Billiton would not proceed with its option on the North Findlay property. Eagle Plains is presently seeking participation on the Findlay Creek project by interested parties.

Hardy Island

Prospecting for dimension stone in 1998 led **Helgi Sigurgeirson** to the waters near Jervis Inlet where he restaked the Hardy Island quarry on Hardy Island (last worked in the 1920s). This quarry was originally one of the Jervis Inlet Granite quarries, a group of quarries which supplied most of the granite for numerous historic buildings erected during the early part of the century. Landmarks of note using stone from the Hardy Island quarry include the breakwater at Ogden Point in Victoria and the Lions at the old courthouse in Vancouver. Sigurgeirson applied for and received a quarry permit in 1999

PROPERTY	PROSPECTOR	PRESENT OPERATOR	EXPENDITURES TO DATE	PLANNED EXPENDTURES
Ample-Goldmax	Dave Javorsky Gary Polischuk	Gold Ore Resources	$850,000	Nil
Bow	Martin Peter	Hudson Bay Mining and Smelting	$140,000	Combined with Lottie
Bizar/Goldstrike	Leo Lindinger	Cassidy Gold Corp.	$47,000	$500,000
Cam-Gloria	Camille Berube	Teck Corp.	$100,000	Nil
Dominion Creek	Allan Raven	Gold City Industries	$220,000	undisclosed
Findlay Creek	Tim Termuende	Eagle Plains Res.	$2,000,000 plus	Undisclosed.
Lottie	Martin Peter	Hudson Bay Mining and Smelting	$720,000	Nil
McNeil Creek	Frank O'Grady	National Gold Corp.	$85,000	$1,000,000
Quill	Allan St. James	Petra Resources	$120,000	Nil
Red Mountain	Charles Kowall	Wheaton River Minerals	>$200,000	Undisclosed
Zymo	Robin Day	Freeport MacMoRan	$200,000	Nil?
	TOTAL		**$4,682,000**	**$1,500,000**

Table 3. PAP-Associated properties discovered prior to 1999 and recently active.

Approximately 1600 tonnes of blocks were shipped from the quarry in 1999, and a further 2500 tonnes was expected to be shipped in 2000, much of which will be exported to the United States. Most of the blocks are processed into split facing, but much is used for custom sizes such as coping. Hardy Island Granite Quarries Ltd. has also recently supplied the stone for work on the Lions Gate Bridge. Though there are subtle differences among the stones from the quarries on Nelson, Kelly, Fox and Hardy islands, all are light grey, medium grained, biotite hornblende granodiorite. The stone at Hardy Island has excellent splitting qualities and well developed jointing.

Lottie

Located just north of the town of Wells, the Lottie claim was staked by 1998 PAP grantee **Martin Peter** in order to cover the area around a new discovery of massive sulphide float. Boulders of mineralized chert and altered volcanic rock occur over a distance of about 75 metres in an area underlain by the Mississippian Antler Formation, potential host to VMS-style mineralization. A sample from one boulder assayed 24.3% copper, 0.4 gram per tonne gold, 19.6 grams per tonne silver, 0.06% cobalt, 0.12% molybdenum, 0.02% lead and 0.04% zinc. The Lottie was optioned to **Eureka Resources Inc.** early in 1999 who spent about $70,000 on exploration before optioning the property to **Hudson Bay Mining and Smelting** in the same year. Hudson Bay spent approximately $650,000 on exploration in 2000 on the combined Lottie and Bow properties, now called **Lottie Lake**. This group consists of 850 contiguous claims. In January 2001, Eureka announced that Hudson Bay would not be exercising its option to conduct further exploration on the Lottie Lake Property.

McNeil Creek

The McNeil Creek property is located 18 kilometres southwest of Cranbrook. **Frank O'Grady** explored the area in 1995 and 1996 after being funded by a PAP grant in each of those years. Underlain by Moyie intrusive rock and Middle Aldridge sediments, O'Grady's Phantom, Mac and Cubby claims represent a Sullivan-type massive sulphide target. In 1996, O'Grady optioned his claims to **Sedex Mining Corp**. In 1998, Sedex drilled a hole to a point just below the Lower-Middle Aldridge contact, encountering minor sulphides. Sedex subsequently optioned the property in 1999 to **Webb Bay Resources Ltd.**

later re-named **National Gold Corp**. which has committed to spend $1,000,000 over four years.

Quill

The Quill property is located 65 kilometres northwest of Stewart, lying on McQuillan Ridge at the confluence of the Unuk and South Unuk rivers. Allan St. James found mineralized boulders in an area where Jurassic diorite intrudes Stuhini and Unuk River volcanic and sedimentary rocks. A large angular diorite boulder with quartz vein containing chalcopyrite, pyrite and marcasite yielded 102 grams per tonne gold, 36 grams per tonne silver, 5.32% copper, 0.01% lead and 0.01% zinc. Other sulphide-bearing quartz vein float contained predominately galena and lead. Prospecting did not locate the source of the high-grade gold-quartz vein boulders but a 250-metre-long open-ended conductor underlying the boulder field was defined during the 1998 PAP-funded geophysics program. With a potential drill target now in place, Petra Resources Corp. optioned the Quill property at the end of 1998. Petra spent $120,000 on exploration in 1999 but elected not to retain the property afterwards.

Red Mountain

Prospector **Charles Kowall** discovered significant gold-silver mineralization on Willoughby Creek east of Stewart while prospecting under a PAP grant received in 1988. Kowall was able to option the property to **Bond International Gold Inc.** who then spent several hundred thousand dollars on exploration. The Company subsequently made further significant discoveries on nearby Red Mountain. Close to $10,000,000 has been spent on the Red Mountain property since Kowall's initial find at Willoughby Creek. The present owners **Wheaton Rivers Minerals** are currently re-examining drill core and evaluating the potential for mining the deposit's higher-grade core.

Zymo

This new porphyry copper-gold target west of Smithers was identified in 1996 by PAP grantee, **Robin Day**. The targets were further outlined and defined with the help of grants in 1997 and 1998. In 1998, **Freeport Copper Company** (FCC), a subsidiary of Freeport McMoRan Copper and Gold Inc., entered into an option agreement to carry out exploration on the Zymo. Six holes were then drilled totaling 1600 metres in 1999. The Zymo property is underlain by a phyllic-altered, pyritic quartz diorite stock with local copper, zinc, lead, silver and gold mineralization and anomalous arsenic+/-antimony rock geochemistry. The presence of extensive phyllic alteration with local copper-silver-gold mineralization is considered encouraging. The property is similar to the Louise Lake prospect, 7 kilometres to the east, which has a calculated resource of 50 million tonnes. About $200,000 was spent on the property in 1999. Freeport has since dropped the Zymo option.

CONCLUSIONS

Again this year the program produced significant benefits for the province. Program funded prospectors were able to option 7 recently discovered mineral occurrences to mining companies for further exploration that has the potential to generate more than $1.35 million worth of exploration activity over the next few years. The funding played a critical role in allowing these grantees to find and then develop their discoveries to a level that excited corporate interest.

A number of other new mineral occurrences were discovered by grantees in 1999 that will see further exploration over the coming years, and in all likelihood lead to more company investment. As well, work done by grantees in previous years continues to generate corporate exploration investment in the province. These previous discoveries by grantees continue to be evaluated and have generated over $4.5 million worth of exploration activity so far. Properties such as Dominion Creek, Red Mountain, McNeil Creek and Findlay Creek will continue to have major exploration development and are a testimonial to the success of the grant program. The newly opened Handy Island quarry, which is presently providing granitic dimension stone for the BC and the US market, is another confirmation of the program's success.

The overall performance of the active grantees in 1999 was excellent. The average number of prospecting days per grantee was 55, the highest for the past 10 years. The final report evaluations were high with 38 (77.6%) of the active grantees scoring 8 out of 10 or higher and only 1 (2%) scoring 5 or lower. The average score was 8.6. These are indicators of the commitment and high quality delivered by the grantees.

Since the end of the 1980s, relatively few companies have been putting up grubstakes for prospectors and the grants have played a much larger role than

normal in keeping prospectors active in this province. Limited funds and the growing number of applicants are the reasons that once again a number of good proposals did not receive funding.

FOR FURTHER INFORMATION

Please contact the Prospectors Assistance Program office, a Regional Geologist or visit our website at:

www.em.gov.bc.ca/Mining/Geolsurv/Prospectors

Prospectors Assistance Office
Program Coordinator - Garry Payie
Ministry of Energy and Mines
Energy and Minerals Division
Geological Survey Branch
P.O. Box 9320, Stn Prov Gov't
5-1810 Blanshard Street, Victoria, BC
Phone (250) 952-0403
Fax: (250) 952-0381
Email: Garry.Payie@gems4.gov.bc.ca

Regional Geologists

South-Central District - Mike Cathro
Ste. 200, 2985 Airport Drive
Kamloops, BC, V2B 7W8
(250) 828-4566
Mike.Cathro@gems2.gov.bc.ca

Southwest District - Jacques Houle
2080-B Labieux Road
Nanaimo, BC
V9T 6J9
(250) 751-7372
Jacques.Houle@gems9.gov.bc.ca

Northeast-Central District - Bob Lane
3990 - 22nd Avenue
Prince George, BC, V2N 3A1
(250) 565-4244
Bob.Lane@gems4.gov.bc.ca

Kootenay District - Paul Wilton
B.C. Access Centre, Ste. 201,
100 Cranbrook St. N.
Cranbrook, BC, V1C 3P9
(250) 426-1658
Paul.Wilton@gems6.gov.bc.ca

Northwest District - Paul Wojdak
Bag 5000, 3793 Alfred Avenue
Smithers, BC, V0J 2N0
(250) 847-7200
Paul.Wojdak@gems5.gov.bc.ca